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ABSTRACT

This curriculum guide outlines three credits of study, one credit for each of the grade levels 10, 11, and 12. Intended as an optional study area, the program provides awareness and exploration for those students who aspire to postsecondary study and introduces skills to those who wish to explore trades and technologies in employment after school. Each level has core and option modules that offer flexibility. Introductory materials include an overview, information on implementation, and goals and objectives. Power Mechanics (PM) 101 has 11 modules: orientation and safety, tools, fasteners and gaskets, manuals, theory of engine operation, lubrication systems, fuel systems, cooling systems, basic electrical system, basic ignition system, and wheels, hubs, and tires. PM 201 has 11 modules: orientation and safety, engine types, engine test and measurement, ignition systems--tune-up, fuel systems, brake system, steering system, suspension and front end alignment, drive train, heating and air conditioning, and engine rebuilding. PM 301 has nine modules: orientation and safety, electrical systems, exhaust systems, automatic transmissions, emission controls, ignition scope analysis, instruments and accessories, engine rebuilding, and heating and air conditioning. Each module has these components: major objective, student objectives, teachers' notes and suggested activities, and suggested materials. Appended are a four-page chart correlating recommended material to module topics and five pages of references. (YLB)

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Manitoba
Education

1987

industrial arts

power mechanics
101, 201, 301

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industrial arts power mechanics

101, 201, 301

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This guide has been developed as part of the revision for Industrial Arts curricula for grades 7 through 12 in Manitoba schools, and replaces the Industrial Arts 10-12 Automotive Mechanics guide of 1968. It has been prepared in response to recommendations provided by the Industrial Arts 10-12 Steering Committee, and subsequently approved by the Curriculum Policy Review Council.

The Power Mechanics 101, 201, 301 Industrial Arts Senior High Curriculum Ad Hoc Committee provided the writer with the necessary technical and pedagogic support in reviewing the curriculum throughout its development.

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overview

OVERVIEW

INTRODUCTION

The Industrial Arts 10-12 Power Mechanics curriculum guide outlines three credits of study, one credit for each of the grade levels 10, 11, and 12. Several general features have been integrated throughout the guides:

1. Industrial Arts provides learning opportunities for students with a wide range of abilities.
2. Career exploration and planning is incorporated into Industrial Arts programs;
3. Industrial Arts at the secondary level assumes that students have had no junior high school exposure to the program area; and
4. Basic and generic skills include problem solving, creative designing and decision making.

This program should be viewed as an optional study area for all secondary students. It provides awareness and exploration for those students who aspire to post-secondary study, as well as introduces skills to those students who wish to explore trades and technologies in employment after school. The avocational use of basic and generic skills serves the entire spectrum of students.

Schools are encouraged to make special efforts to include students in Industrial Arts programs who would normally perceive this area as traditionally suited to persons of the opposite sex. It is especially possible for the practical arts to play an important role in reversing sex-role stereotyping.

RATIONALE

Power Mechanics 101, 201, 301, with its "hands-on" emphasis has been designed to provide students with the opportunity to develop generic skills. Specifically, the Power Mechanics program offers experiences in the following areas:

- planning
- diagnosing
- assessing and estimating costs
- evaluating
- troubleshooting
- adjusting
- problem solving
- decision making

Generally, Power Mechanics 101, 201, 301 allows the student a flexible curriculum through which one can exercise time management, quality control, and teamwork.

This curriculum guide is a statement of INTENT, CONTENT, and DEPTH of study. It is prepared for the teacher as a guideline rather than a mandatory prescription. While teachers are invited to develop their course of study around this curriculum guide, it is ultimately left to each teacher to assess and prepare their courses in accordance with their preferences for emphasis, the nature of facilities, their preception of student needs, school and administration philosophies, and community requirements. The use of CORE and OPTION modules is recommended to help the teacher accommodate the variables affecting the program.

STRUCTURE OF THE PROGRAM

Power Mechanics 101, 201, 301 assumes that students who enter the program area for the first time, will begin study at the 101 level. Each level has CORE modules which must be studied to the extent as set by the teacher, and OPTION modules which offer the flexibility described in the Rationale for this course.

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implementation

IMPLEMENTATION

SAFETY

Industrial Arts courses, being practical and "hands-on" in nature, require that schools and teachers plan implementation strategies with care to safety concerns. Throughout this guide, special mention is made of safety concerns with regard to higher risk activities. However, SAFETY IS A CONCERN AT ALL TIMES, and it is the responsibility of those who deliver the courses to ensure that adequate and reasonable safety precautions are taken.

TIME ALLOTMENT

Power Mechanics 101, 201, and 301 are considered to be secondary school credits, with each credit intended to be comprised of 110-120 hours of study. It is left to the schools to adjust their preferred emphases within the course objectives so that unique needs may be met using this guide.

INTEGRATION OF TOPICS

Whereas this curriculum guide provides a suggested sequence of modules and topics within modules, it is recommended that the implementation of the course be based upon continued integration and revision of the following topics:

- safety
- career exploration
- consumerism
- applied mathematics
- communication skills

Teachers are expected to integrate topics as suited to their unique preferences, emphases, laboratory requirements, student needs and sequencing of topics within the course.

In some instances, it may be the teacher's choice to provide a THEME around which the course will be implemented. The following themes are commonly found integrated in Industrial Arts programs:

1. Process Orientation - a theme which emphasizes the systematic use of materials;

2. Product, or Project Orientation - a theme which focusses on the net result of skills developed;

3. Design Orientation - a theme which develops the creative problem solving, and decision making processes in a generic sense;

4. Tools and Materials Orientation - a theme which focusses on the equipment and supplies used in that particular area of Industrial Arts.

Power Mechanics 101,201,301 may be taught in Industrial Arts laboratories which provide a wide range of facilities and program emphases. It is left to the teacher to make the necessary judgements as to whether some objectives will be taught merely as theory or whether they may be taught as hands-on practical skills, depending upon the facility at hand.

MATERIALS

Supplemental material, both for student and teacher reference, is referred to throughout the guide. More detailed bibliographic data is provided in an appendix to this guide.

SPECIAL NEEDS STUDENTS

Industrial Arts 101, 201, 301 is designed as an option program for ALL STUDENTS in the secondary school. Many pupils headed for the technical areas of colleges and universities benefit from secondary exposure to the areas of design, engineering, electronics, and the trades. Industrial Arts serves the special needs of the university student.

The special needs of the greatest number of secondary students would include the exploratory and generic skills development emphasized in Industrial Arts. There is a strong linkage between the practical arts and life-long avocational skills necessary to every-day life.

Industrial Arts can provide some motivational value to students who enroll in these courses because they offer "alternative" credits to other less pragmatic options. The "hands-on" nature of Industrial Arts provides a multifaceted dimension to learning. The many senses involved in practical arts offer students a greater chance to experience success in their particular learning modes. While Industrial Arts is NOT DESIGNED TO BE AN AREA OF STUDY FOR THE LEARNING IMPAIRED, it CAN accommodate students in unique ways.

Many innovative programs for the physically handicapped have been developed with safety precautions being taken into account. The use of jigs and fixtures for specific handicaps has offered new successes to such students. Tailoring Industrial Arts to the handicapped requires not only a careful scrutiny of hazards, safety requirements, methodologies, and special supports (fixtures, jig aides), but also the recognition necessary from administrators and colleagues.

EVALUATION

Industrial Arts involves both theoretical and practical learning. Teachers are expected to conduct student evaluations in accordance with: their predetermined course planning (syllabus); the special theme or orientation used in the implementation; the specific objectives set for each student (special needs taken into account); and the standards of performance agreed upon at the outset. These are VALIDITY issues which will reflect the appropriateness of grades issued.

Generally, teachers agree upon this range of criteria However, each teacher must provide a unique WEIGHTING to validate his/her special choice of program variables implemented.

goals and objectives

GOALS AND OBJECTIVES

PROGRAM GOALS

The general goals of the senior high school Industrial Arts programs include the following:

1. to develop creative potential in both vocational and avocational life;
2. to gain an awareness of the role played by technology in the modern world;
3. to assist in the selection of a career choice and career plan;
4. to acquire basic and generic skills in the safe use of common industrial tools and machines, and in the implementation of processes;
5. to develop a learning environment and attitude that fosters achievement in a practical manner;
6. to discover and develop talents, aptitudes and interests;
7. to develop problem solving skills;
8. to enhance one's understanding of self;
9. to develop teamwork attitudes and skills;
10. to develop an appreciation for decision making and problem solving techniques.

OBJECTIVES

The following listing includes all of the objectives cited in the Level II section of this guide.

While the implementation of the objectives is required for both the CORE and OPTIONAL modules, it is left to individual teachers to assess whether certain objectives will be integrated generally or taught individually.

Emphasis and sequencing are also left to the teachers' judgment based on personal preferences, assessment of student needs and preferences, the nature of facilities and/or the particular theme around which the course is delivered (process, product, design, or tools orientation.

Power Mechanics 101:

1. Student Orientation and Safety

   The student should be able to:

   - outline the historical development of power mechanics;
   - demonstrate an awareness of the modules in power mechanics;
   - recognize the relationship between junior-high and senior-high power mechanics;
   - identify and use reference materials;
   - identify careers associated with power mechanics
   - locate information about power mechanics occupations;
   - demonstrate the understanding of the need for safety and safety equipment;
   - demonstrate an understanding of safety standards as they apply to the power mechanics lab;
   - describe procedures to be followed in the power mechanics lab;
   - demonstrate safe habits;

   list hazardous conditions in the power mechanics lab;

- identify emergency procedures to be followed in case of accidents;
- demonstrate an understanding of the use of fire extinguishers;
- complete accident reporting procedures;
- wear apparel appropriate for a power mechanics lab;
- demonstrate proficiency in safety tests.

2. Tool Identification and Use

The student should be able to:

- identify basic hand tools;
- use basic hand tools safely;
- list the various power tools in the power mechanics lab;
- demonstrate the correct use of various power tools;
- explain the importance of measurement and precision to power mechanics;
- identify measuring devices;
- demonstrate the correct use of precision/ measuring tools;
- list the basic cutting tools in the power mechanics lab;
- use basic cutting tools safely;
- identify basic speciality equipment used in a power mechanics lab;
- explain the importance of tool care and maintenance.

3. Fasteners and Gaskets

The student should be able to:

- explain safety rules as they apply to fastening devices;
- identify types of fasteners;
- explain the purposes of various fasteners;
- list glues used in power mechanics;
- list rivetting methods;
- explain the purpose of gaskets and seals;
- list gasket and seal materials;
- identify special tools used with fasteners;
- define welding;
- explain the procedure for arc welding;
- identify the equipment required for arc welding;
- demonstrate procedures for setting up and using arc welding equipment;
- identify equipment for oxy-acetylene welding;
- list the steps in setting up for oxy-acetylene welding;
- list the steps in turning off oxy-acetylene equipment;
- identify equipment required for oxy-acetylene cutting;
- demonstrate safe procedures in cutting with oxy-acetylene equipment.

4. Use of Manuals

The student should be able to:

- recognize the importance of accurate information with regard to power mechanics;
- demonstrate the necessary skills in using indexes with manuals;
- locate instructions and specifications in a manual;
- read a specification sheet in a lab manual;
- recognize the importance of keeping a manual clean.

5. Theory of Engine Operation

The student should be able to:

- define *engine*;
- identify basic types of engines;
- demonstrate an understanding of the principles of engine operation;
- define *work*, *energy*, *power*, *horsepower*, and *torque*;
- identify methods of classifying engines;
- explain the firing order of an engine;
- explain an engine's power rating;
- demonstrate an understanding of the basic principles of an internal combustion engine;
- demonstrate familiarity with the terms which describe the mechanical, operational, and power features of an internal combustion engine;
- identify engine cycles;
- explain the engine cycles;
- name the various parts of a simple internal combustion engine and their relationship to one another;
- explain the need for and application of light-weight materials;
- explain the need for improved replacement parts and materials;
- explain engine assembly and disassembly procedures;
- disassemble, inspect and assemble a 2- and 4-stroke cycle engine;
- describe rotary-engine operation;
- list other experimental engines.

6. Lubrication Systems, Lubricants and Bearings

The student should be able to:

- define *friction*;
- explain the function of the lubrication system;
- identify the different types of lubrication systems;
- list the types of oil pumps;
- identify the types and composition of lubricants;
- list the jobs a lubricant must perform;
- describe oil classification systems;
- explain the purpose of oil additives;
- list advantages and disadvantages of synthetic oil;
- explain the purpose of oil filters;
- list the types of filtration systems;
- identify types of oil filters;
- identify tools and equipment for servicing/lubricating engines and chassis;
- identify common lubrication problems and provide solutions;
- perform lubrication system services;
- list the classes of friction;
- explain the purpose of bearings;
- list and describe the types of bearings.

7. Fuel Systems

- identify types of fuels;
- describe properties of gasoline and diesel fuel;

- describe the purpose of the fuel system;
- list alternate automotive fuels;
- define fuel systems;
- identify types of fuel systems;
  describe the purpose of the fuel system;
- identify components of the fuel-supply system;
- describe how fuels affect engine performance;
- identify problems related to abnormal
- combustion;
- identify problems related to diesel fuel systems;
- identify types of emission-control systems;
- identify types of carburetors;
- summarize carburetor operating principles;
- identify basic parts of a carburetor;
- diagnose common carburetor problems;
- perform basic external carburetor adjustments;
- describe the operation of computer-controlled carburetors;
- define fuel injection;
- describe fuel injection;
- identify variations of fuel injection systems;
- list advantages of fuel injection.

8. Cooling Systems

The student should be able to:

- identify safety requirements with regard to cooling systems;
- identify the need for a cooling system;
- list the functions of the cooling system;
- identify the types of cooling systems;
- describe the difference between an air-cooled and a liquid-cooled engine;
- list the parts within a liquid-cooled system;
- explain the function of the parts of a liquid-cooled system;
- list the types of radiators;
- list the parts of a radiator;
- explain the purpose of a shroud;
- list the parts within an air-cooled system;
- explain the function of the parts of an air-cooled system;
- list the types of fans;
- inspect and diagnose problems related to a cooling system;
- identify special tools to service cooling systems;
- perform general repair and maintenance on cooling systems.

9. Basic Electrical System

The student should be able to:

- define voltage, current, resistance;
- state Ohm's Law;
- solve problems using the three forms of Ohm's Law;
- define series circuit;
- define parallel circuit;
- draw and construct series and parallel circuits;
- explain the purpose of a battery;
- identify types of batteries;
- describe the construction and operation of batteries;
- identify battery testing and charging procedures;
- perform procedures safely in testing and charging a battery;

- identify tools and equipment required for battery testing and maintenance;
- identify basic components in an auto wiring circuit;
- identify circuit protection devices;
- identify tools and equipment required for circuit testing;
- test and repair electrical circuits.

10. Basic Ignition System

The student should be able to:

- identify the safety aspects related to the ignition system;
- define ignition system;
- list the types of ignition systems;
- identify the components of the primary circuit;
- identify the components of the secondary circuit;
- explain the function of the ignition system components;
- identify the components of a magneto ignition system;
- explain the function of the components of a magneto ignition system;
- identify the components of the electronic ignition system;
- explain the function of electronic ignition system components;
- list the advantages of an electronic ignition system;
- explain the need for a tune-up;
- identify components to be checked in performing a tune-up;
- explain the need for advanced timing;
- draw a contact point and electronic ignition schematic and label the parts;
- identify tools and equipment required in performing a tune-up;
- perform a minor tune-up.

11. Wheels, Hubs and Tires

The student should be able to:

- describe the need for wheels/hubs;
- list the types of rims used today;
- describe wheel design;
- demonstrate safe maintenance practices as the relate to wheels, hubs and tires;
- explain the need for tires;
- explain tire sizes;
- identify tire construction and types of tires;
- explain the importance of proper tire inflation;
- demonstrate how to remove a tire from a rim;
- demonstrate how to replace a tire on a rim;
- explain the need for tire balancing;
- explain static and dynamic balance;
- identify tools and equipment for tire balancing;
- explain the recommended tire rotation for given vehicles;
- identify tire-wear problems.

Power Mechanics 201:

1. Student Orientation and Safety

The student should be able to:

- outline the historical development of power mechanics;

- demonstrate an awareness of the modules in Power Mechanics 201;
- demonstrate an understanding of the course requirements for 201 Power Mechanics;
- identify and use reference materials;
- identify careers associated with power mechanics;
- locate information about power mechanics occupations;
- demonstrate an understanding of the need for safety and safety equipment;
- demonstrate an understanding of safety standards as they apply to the power mechanics lab;
- describe procedures to be followed in the power mechanics lab;
- demonstrate safety habits;
- list hazardous conditions in the power mechanics lab;
- identify emergency procedures;
- demonstrate an understanding of the use of fire extinguishers;
- demonstrate an understanding of accident reporting procedures;
- wear apparel appropriate for a power mechanics lab;
- demonstrate proficiency in safety.

2. Engine Types

The student should be able to:

- describe the differences between a two- and four-stroke cycle engine;
- list the advantages of two- and four-stroke cycle engines;
- identify various applications of a two- and four-stroke cycle engine;
- describe rotary (Wankel) engine operation;
- demonstrate an understanding of rotary engine construction;
- describe diesel engine operation;
- demonstrate an understanding of diesel engine construction;
- describe K-cycle engine operation;
- demonstrate an understanding of K-cycle engine construction;
- list the various valve arrangements;
- identify the methods of two-stroke cycle valving;
- describe the effect valve position has on the combustion chamber;
- list the types of valve trains;
- identify the different types of combustion chamber designs;
- list the types of cylinder arrangements;
- explain the differences in cooling system applications;
- list the various fuel classifications;
- identify other experimental engines;
- explain the operating principles of experimental engines.

3. Engine Test and Measurement

The student should be able to:

- define horsepower;
- state how horsepower is measured;
- demonstrate an understanding of thermal efficiency;
- define mechanical efficiency;
- define indicated horsepower;
- define brake horsepower;
- define real or true horsepower measurement;
- explain volumetric efficiency;
- calculate problems using the cubic-inch formula;

- calculate problems using the compression-ratio formula;
- explain the effects of emission controls when testing engines.

4. Ignition Systems: Tune-Up

The student should be able to:

- explain the need for a tune-up;
- identify hazards associated with tune-ups;
- identify the components of a conventional ignition system;
- identify the components of an electronic ignition system;
- identify the components of a computerized ignition system;
- perform a dwell test and RPM test;
- perform timing tasks;
- identify tools and equipment for tune-up procedures;
- correct minor ignition problems;
- demonstrate minor troubleshooting tasks on the conventional and electronic ignition systems;
- work in a safe manner with ignition systems;
- describe engine tune-up procedures;
- list items to be checked in performing a tune-up;
- identify special engine tune-up instruments;
- explain the need for a wet and dry compression test;
- perform a complete compression test;
- diagnose tune-up problems;
- perform a tune-up.

5. Fuel Systems: Carburetion-Fuel Injection-Overhaul

The student should be able to:

- identify various energy propellants;
- explain the purpose of fuel additives;
- identify the additives that makeup fuel;
- describe operating principles of the carburetor;
- name the main parts of a simple carburetor,
- identify the various parts of a simple carburetor;
- overhaul a simple carburetor;
- perform various internal carburetor adjustments;
- fine-tune a carburetor;
- explain procedures for diagnosing carburetor-related problems;
- demonstrate troubleshooting methods which relate to carburetion;
- demonstrate an understanding of the gasoline fuel injection system;
- list the types and classifications of fuel injection systems;
- explain service procedures for fuel injection systems.

6. Brake System

The student should be able to:

- identify the hazards related to working on brake systems;
- practice safety procedures related to the brake system;

- describe the purpose and principles of brake operation;
- explain the importance of brake fluid;
- list the characteristics of brake fluid;
- explain the operation of a single master cylinder, with its component parts;
- explain the operation of a dual master cylinder, with its component parts;
- explain the operation of a quick takeup diagonal master cylinder;
- describe the operation of drum brakes;
- describe the operation of disc brakes;
- explain the operation of a combined drum and disc unit;
- describe the operation of power brakes;
- describe the operation of current innovations to the brake system;
- identify special tools necessary for brake servicing;
- repair drum and disc brakes;
- bleed a brake system.

7. Steering System

The student should be able to:

- explain steering geometry;
- explain the parallelogram steering linkage;
- list the component parts of a simple steering linkage train;
- discuss a schematic drawing of a rack and pinion steering system;
- list the component parts of a simple rack and pinion steering system;
- explain the need for a steering gear box;
- list the different types of manual steering gear boxes;
- describe how each manual gear box works;
- name the types of power steering systems;
- describe how each power steering system works;
- describe the different types of collapsible steering columns.

8. Suspension and Front-End Alignment

The student should be able to:

- explain the need for suspension systems;
- describe the operation of leaf spring and coil spring suspension;
- describe the operation of torsion bar suspension;
- explain I-beam suspension;
- explain solid axle suspension (front and back);
- explain front wheel independent suspension operation;
- describe 4-wheel independent suspension;
- describe the purpose of shock absorbers;
- list various types of shock absorbers;
- explain the need for a stabilizer bar;
- understand the importance of wheel alignment;
- describe the principles of wheel alignment;
- describe toe-in at a stationary position;
- describe toe-out at a turning position;
- recognize the relationship between front-end and rear-wheel alignment and steering systems;
- identify tools necessary for front-end repair;

9. Drive Train: Clutch-Transmission-Differential

The student should be able to:

- identify the hazards related to various aspects of the drive train;

- explain the need for a clutch;
- list the parts of a clutch assembly;
- describe the operating principles of the clutch;
- identify the different types of clutch assemblies;
- identify different clutch troubles;
- identify tools necessary for clutch repair;
- adjust a clutch assembly;
- remove and replace a clutch assembly;
- describe the purpose of a transmission;
- list and describe the parts of a manual transmission;
- explain the operation of a simple manual transmission;
- explain the function of the drive line;
- list and describe the parts of a front-wheel drive assembly transaxle;
- describe types of universal joints;
- repair a rear-wheel drive propeller shaft universal joint;
- describe the purpose of a differential;
- identify the components of a rear-wheel drive assembly;
- list the different types of rear-axle assemblies;
- list the different types of traction or grip differentials;
- describe the construction and operating principles of the differentials;
- describe the importance of the crown and pinion tooth pattern;
- demonstrate an awareness of the four-wheel drive system.

10. Heating and Air Conditioning

The student should be able to:

- explain how a heating system operates;
- list the different methods of heat-output control;
- explain the need for a water valve;
- describe the function of a thermostat;
- explain the need for air conditioning in all types of weather;
- list the principles of refrigeration;
- list the component parts that makeup an air-conditioning unit in an automobile;
- describe the operation of a manual refrigeration system;
- describe the operation of an automatic refrigeration system;
- explain the operation of a cycling clutch orifice tube (CCOT) compressor;
- explain a schematic drawing of a simple car-air conditioning unit and label the major component parts;
- demonstrate safe use of air-conditioning test equipment;
- demonstrate how to discharge an air-conditioning unit;
- demonstrate how to recharge an air-conditioning unit;
- list all the dangers when working with refrigerant;
- perform some minor troubleshooting and repairs on air-conditioning units.

11. Engine Rebuilding

The student should be able to:

- identify all safety requirements as they relate to engine rebuilding;
- identify the need for an engine rebuild;
- demonstrate the ability to remove an engine;
- demonstrate the ability to disassemble an engine systematically;
- inspect and assess the wear of parts;
- replace or repair worn parts;
- reassemble the engine;
- identify safe procedures when installing an engine;
- install the completed engine;
- demonstrate start-up procedures, and do all final adjustments required for fine tuning.

Power Mechanics 301:

1. Student Orientation and Safety

The student should be able to:

- outline the historical development of power mechanics;
- demonstrate an awareness of the modules in Power Mechanics 101,201,301;
- review the course requirements for 301 Power Mechanics;
- identify and use reference materials;
- identify careers associated with power mechanics;
- locate information about power mechanics occupations;
- demonstrate an understanding of the need for safety and safety equipment;
- demonstrate an understanding of safety standards as they apply to the power mechanics lab and the automobile;
- describe procedures to be followed in the power mechanics lab;
- demonstrate responsibility for developing safety habits;
- list hazardous conditions in the power mechanics lab;
- identify emergency procedures;
- explain the use of fire blankets and fire extinguishers;
- demonstrate accident reporting procedures;
- wear apparel appropriate for a power mechanics lab;
- demonstrate proficiency in safety.

2. Electrical Systems

The student should be able to:

- explain the need for safety when dealing with electrical systems;
- identify the function of starters;
- list the types of starters found on automobiles;
- list the components of a simple starter;
- describe the theory behind starter operation;
- explain the need for a solenoid;
- identify the component parts of a solenoid;
- describe the theory behind solenoid operation;
- describe the function of the starter drive;
- test and identify starter and solenoid components;

- diagnose and repair starter problems;
- disassemble and assemble a starter;
- discuss and label a schematic of the starter motor and solenoid;
- explain the function of a relay;
- explain the function of a neutral safety switch;
- list the requirements necessary to produce electricity;
- explain the function of an alternator;
- identify the three common types of alternators;
- list the component parts of an alternator;
- describe the theory of operation of an alternator;
- test and repair problems;
- describe the function of a diode;
- explain the need for a regulator;
- list the types of regulators in use;
- describe the operation of a voltage regulator;
- test and explain regulator problems;
- inspect and repair wiring problems.

3. Exhaust Systems

The student should be able to:

- explain the need for safety when working with exhaust systems;
- explain the need for an exhaust system;
- identify the types of exhaust systems;
- list the parts of the exhaust system;
- describe the need for each exhaust system component;
- list the types of mufflers;
- identify the functions of catalytic converters in use;
- describe the function of a resonator;
- diagnose exhaust system problems;
- repair or replace exhaust system components.

4. Automatic Transmissions

The student should be able to:

- explain the need for safety when working with automatic transmissions;
- explain the theory behind hydraulics;
- list the different types of automatic transmission fluids;
- list the various types of torque converters;
- explain torque converter theory of operation;
- explain the lock-up operation within a torque converter;
- list the common types of automatic transmissions;
- describe the basic operations of an automatic transmission;
- describe the purpose of a hydraulic pump;
- explain the function of clutches;
- explain the function of bands;
- describe the planetary gear system;
- describe the function of the valve body;
- explain the purpose and function of the governor and modulator;
- explain a power flow chart;
- perform basic troubleshooting tasks.

5. Emission Controls

The student should be able to:

- recognize the importance of clean air;
- list the various types of emission control devices;

- explain how each type of emission control device operates;
- test and verify the operation of emission control devices;
- repair or replace emission control devices;
- diagnose and verify the level of exhaust emissions;
- inspect all hoses and connections to the emission control devices.

6. Ignition Scope Analysis

The student should be able to:

- explain the need for safety when working on the ignition system;
- explain the need for ignition analysis;
- identify and inspect engine ignition components;
- connect an oscilloscope to electronic and conventional ignition systems;
- recognize basic scope patterns;
- identify the various controls and meters on the oscilloscope;
- demonstrate an ability to diagnose ignition and related problems as observed on the scope;
- solve observed problems and verify the remediation by using the oscilloscope;
- identify where computer controls are used on automobiles;
- describe the function of computer controls;
- list the advantages of computer controls.

7. Instruments and Accessories

The student should be able to:

- explain safety precautions when working with electrical instruments;
- list the major instruments and accessories;
- explain the purpose of each instrument and accessory;
- demonstrate the ability to use various testing equipment;
- diagnose major instruments and accessory problems;
- solve instrument and accessory problems;
- identify other minor accessories found on automobiles.

8. Engine Rebuilding

The student should be able to:

- identify all safety requirements as they relate to engine rebuilding;
- identify the need for an engine rebuild;
- demonstrate the ability to remove an engine;
- demonstrate the ability to disassemble an engine systematically;
- inspect and assess the wear of parts;
- replace or repair worn parts;
- reassemble the engine;
- identify safe procedures when installing an engine;
- install the completed engine;
- demonstrate the start-up procedures, and do all final adjustments required for fine-tuning.

9. Heating and Air Conditioning

The student should be able to:

- explain how a heating system operates;
- list the different methods of heat-output control;
- explain the need for a water valve;
- describe the function of a thermostat;
- explain the need for air conditioning in all types of weather;
- list the principles of refrigeration;
- list the component parts that makeup an air-conditioning unit in an automobile;
- describe the operation of a manual refrigeration system;
- describe the operation of an automatic refrigeration system;
- explain the operation of a cycling clutch orifice tube (CCOT) compressor;
- explain a schematic drawing of a simple car air-conditioning unit and label the major component parts;
- demonstrate safe use of air-conditioning test equipment;
- demonstrate how to discharge an air-conditioning unit;
- demonstrate how to recharge an air-conditioning unit;
- list all the dangers when working with refrigerant;
- perform some minor troubleshooting and repairs on air-conditioning units.

power mechanics 101

POWER MECHANICS 101

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STUDENT ORIENTATION AND SAFETY (PM101-01)

Major Objective: To enable the student to explore and relate the significance of power mechanics to the needs of individuals, industry and society, and to develop safe practices in the use of tools, machines and processes.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. STUDENT ORIENTATION		
The student should be able to:		
1. Outline the historical development of power mechanics.	Have students maintain a notebook throughout the course. Discuss the historical development of automotive construction from the era of the horseless carriage to the present. Have students develop a portfolio of the chronology of the automobile.	
2. Demonstrate an awareness of the modules in Power Mechanics.	Use transparencies, charts, and/or handouts to provide students with information about the various modules in Power Mechanics. Discuss with students the goals which are common to all levels of Industrial Arts. Provide students with a course outline and the evaluation procedures.	
3. Recognize the relationship between junior-high and senior-high power mechanics.	Discuss the role of Industrial Arts in the general education of students. Relate the discussion to the definition and program goals of Industrial Arts, and in particular, Power Mechanics.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Identify and use reference materials.	Provide students with opportunities to use reference materials for problem solving, technical research, and report writing.	Reference Materials 1. Catalogues 2. Textbooks 3. Service Manuals 4. Periodicals 5. Tool manuals 6. Directories 7. Audio-visual materials
5. Identify careers associated with power mechanics.	Integrate information and learning activities about careers and opportunities associated with power mechanics. Acquaint students with programs available in post-secondary education which would be extensions in related fields of their secondary education.	
6. Locate information about power mechanics occupations.	Encourage students to prepare research reports, charts and bulletin boards on power mechanics career opportunities. Invite guest speakers. Refer to the guidance department and Canada Manpower for career information.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. SAFETY		
The student should be able to:		
1. Understand the need for safety and safety equipment.	Discuss the contribution of safety knowledge, skills, and positive attitudes to safe living and working conditions in homes, schools and communities.	Safety Equipment 1. Safety glasses 2. Footwear 3. Guards 4. Ear plugs 5. Gloves 6. Head gear
2. Demonstrate an understanding of safety standards as they apply to the power mechanics lab.	Make students aware of the importance of legislation, codes, and safety training in power mechanics. Conduct shop/lab tour(s), noting the location and purpose of various safety equipment.	
3. Describe procedures to be followed in the power mechanics lab.	Discuss the importance of safety behaviour and practices. Although safety is an ongoing process, a safety pre-test should be conducted before students participate in shop/lab activities. Have the students participate in the preparation or review of a safety procedures "manual" to be issued to future students.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Demonstrate safe habits.	Have students list and assess the consequences of unsafe acts relating to persons, materials, tools and equipment. Point out that good housekeeping practices aid in preventing accidents as well as in providing a pleasant, well-organized environment for work and learning.	
5. List hazardous conditions in the power mechanics lab.	Emphasize the importance of safety rules. Explain and demonstrate the ABC of Safety: "Always Be Careful." Have students accept responsibility for daily routine procedures such as clean-up, security checks, and reporting problems to the teacher.	Sources of Potential Danger 1. Hand tools 2. Compressed air 3. Power tools/equipment 4. Jacking devices 5. Hoists 6. Jack stands 7. Hot metal 8. Co-venting 9. Welding equipment
6. Identify emergency procedures to be followed in case of accidents.	Make students aware of emergency procedures related to first aid, fire, and accidents. Note location of eye wash station(s), power switches, alarms and panels.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
7. Demonstrate an understanding of the use of fire equipment.	Discuss the different types and limitations of fire extinguishers. Discuss the location, and demonstrate the use of a fire extinguisher. Review and practice emergency procedures for leaving the shop/laboratory.	
8. Complete accident reporting procedures.	Establish a procedure for reporting all accidents, no matter how trivial. Explain reporting procedures and the purpose for accident report forms. Record health problems students might have.	School Policy manual
9. Wear apparel appropriate for a power mechanics lab.	Discuss appropriate clothing and other protective devices for the work being done. Point out the hazards associated with loose clothing, jewellery, long hair and long sleeves. Discuss and demonstrate methods of sanitizing protective devices. Stress the importance of eye protection whenever working in a power mechanics shop/lab.	
10. Demonstrate proficiency in safety tests.	Conduct regular safety tests to monitor the students' proficiency in various shop activities.	

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TOOL IDENTIFICATION AND USE (PM101-C2)

Major Objective: To develop a student's ability to recognize various tools and equipment used in power mechanics and to establish appropriate skills in their use.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. HAND TOOLS		
The student should be able to:		
1. Identify basic hand tools.	Have students identify and name common hand tools used in a power mechanics lab. Discuss tool quality and point out features: . industrial vs hobby application . brand names . material composition . design features	Hand Tools 1. Wrenches 2. Screwdrivers 3. Hammers 4. Mallets 5. Files 6. Pliers 7. Pullers
2. Use basic hand tools safely.	Demonstrate the proper use of common hand tools. Emphasize the safe use of tools; i.e., to always pull and never push on a wrench. Provide examples of right and wrong tool application. Emphasize the importance of using the appropriate tool for the job.	
B. POWER TOOLS		
The student should be able to:		
1. List the various power	Conduct a shop tour, identifying and locating	Power Tools 1. Drills

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
tools in the power mechanics lab.	the power tools in the power mechanics lab. Use transparencies, overheads, filmstrips, and charts for reference material to familiarize students with various applications of power tools.	2. Lathes 3. Grinders 4. Wire wheels 5. Impact drivers 6. Drill presses 7. Floor jacks 8. Transmission jacks 9. Hoist 10. Hydraulic presses
2. Demonstrate the correct use of various power tools.	Provide students with various job tasks to reinforce power tool applications.	
C. MEASURING TOOLS		
The student should be able to:		
1. Explain the importance of measurement and precision to power mechanics.	Discuss why precision is very critical in the design and make-up of various components in power mechanics.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify measuring devices.	Demonstrate how various measuring devices are used. Point out features such as: . threaded . sliding and spring Use filmstrips, charts, posters and other reference material to reinforce measuring device applications.	Measuring Devices 1. Feeler gauges 2. Inside-outside calipers 3. Micrometers 4. Dial indicators 5. Telescoping gauges 6. Torque wrenches 7. Steel rules 8. Straight edges 9. Tread depth gauges 10. Plastigauges
3. Demonstrate the correct use of precision/measuring tools.	Provide students with contract sheets identifying various measurement problems; ie: determining the breaking point of a bolt using a torque wrench, measuring components, etc. Provide a variety of problems so students obtain experience in using several precision/measuring tools.	
D. CUTTING TOOLS The student should be able to:		
1. List the basic cutting tools in the power mechanics lab.	Demonstrate various cutting tools and applications. Emphasize the importance of safety with regard to each type of cutting operation.	Cutting Tools 1. Chisels/punches 2. Hacksaws 3. Snips/shears

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
		4. Welding torches 5. Power-driven hole saws 6. Tubing cutters
2. Use basic cutting tools safely.	Emphasize the importance of eye protection and appropriate apparel.	
E. SPECIALTY EQUIPMENT The student should be able to:		
1. Identify basic speciality equipment used in a power mechanics lab.	Discuss with students the need for some specialty equipment in performing certain operations in a power mechanics lab. Have students explain the purposes of: . stands . fender covers . exhaust hoses . locking devices, pins, etc.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
F. TOOL MAINTENANCE		
The student should be able to:		
1. Explain the importance of tool care and maintenance.	Point out general tool maintenance measures: . always wipe tools after use . inspect regularly for damage/cracks . return tools to their respective places . service on a regular basis Emphasize that certain measuring instruments are delicate and require special attention.	

FASTENERS AND GASKETS (PM101-03)

Major Objective: To develop a student's ability to recognize various fasteners and gaskets and to understand their use.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain safety rules as they apply to fastening devices.	Emphasize the basic rules and principles governing such matters as torque limits and torque patterns, different thread designs, and the shape and purpose of the hardware involved.	
2. Identify types of fasteners.	Have students identify fasteners. Make students aware of the great variety, types and sizes of fasteners used in the automobile industry.	Types of Fasteners 1. Mechanical - bolts - screws - rivets - pins - clips/crimps - studs - keys - snap rings - interference (machine) fit 2. Adhesion - glues - gaskets 3. Fusion - soldering - brazing - welding

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Explain the purposes of various fasteners.	Explain the importance of using correct fasteners in critical areas such as power trains, steering systems and engines.	
4. List glues used in power mechanics.	Have students prepare a listing of glue categories, their characteristics, and their applications in power mechanics.	Glues 1. Epoxy 2. Contact cement 3. Silicone
5. List rivetting methods.	Demonstrate proper rivetting procedures and discuss with students applications of each.	Rivetting Methods 1. Blind rivetting 2. Hammer rivetting
6. Explain the purpose of gaskets and seals.	Have students discuss and define gaskets and seals. Make students aware of the following, regarding gaskets and seals: . gaskets and seals are required to prevent leakage of liquids and gases between two parts . gaskets must be made of some compressible material . some gaskets must be resilient in nature . gaskets could serve as shims . gaskets are available in a wide range of shapes, sizes, materials, costs	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
7. List gasket and seal materials.	Show students illustrations/examples of gaskets and seals and have them name the materials used. Have students refer to various manufacturers' brochures, pamphlets, etc. for updated information.	Gasket Materials 1. Metal 2. Cork 3. Paper 4. Asbestos 5. Rubber 6. Silicone Seal Materials 1. Leather 2. Felt 3. Fibre 4. Rubber
8. Identify special tools used with fasteners.	Have students prepare a listing of special fastening tools and explain the importance of using proper tools.	Special Tools 1. Snap ring pliers 2. Torx drivers 3. Allen wrenches 4. Flare nut wrenches
9. Define welding.	Have students discuss and define welding. Emphasize safety procedures pertinent to welding, especially eye protection to the welder and anyone watching.	Welding To join two pieces of metal together by melting the two sections so they flow together. Extra metal is usually added while welding is in progress.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Explain the procedure for arc welding.	Demonstrate the procedures for setting up and using arc-welding equipment. Emphasize safety procedures to be applied at all times.	
11. Identify the equipment required for arc welding.	Discuss arc-welding equipment using illustrations, filmstrips and examples of each. Have students list the tools and equipment used in arc welding.	Arc-Welding Equipment 1. Arc-welding machine 2. Electrode holder 3. Ground clamp 4. Cables 5. Electrodes 6. Head shield 7. Gloves 8. Aprons 9. Chipping hammer 10. Wire brush 11. Protective curtain
12. Demonstrate procedures for setting up and using arc-welding equipment.	Have students identify the proper procedures in setting up and using arc-welding equipment. If time permits, have students make simple welds following these procedures. Emphasize safety.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
13. Identify equipment for oxy-acetylene welding.	Have students draw up a list of equipment for oxy-acetylene welding with an explanation of each component. Identify and describe the use of safety devices.	Oxy-acetylene Welding Equipment 1. Oxygen cylinder 2. Acetylene cylinder 3. Oxygen regulator gauge 4. Acetylene regulator gauge 5. Welding torches 6. Torch tips 7. Connecting hoses 8. Lighter 9. Truck 10. Goggles
14. List the steps in setting up for oxy-acetylene welding.	Demonstrate the sequential steps in setting up for oxy-acetylene welding. Test students on set-up procedures.	Setting-Up Steps 1. Secure cylinders 2. Remove safety caps 3. Crack cylinder valves 4. Connect regulators to cylinders 5. Connect hoses to regulators 6. Connect hoses to torch body 7. Insert welding tip 8. Adjust regulators 9. Check for leakage 10. Light the torch 11. Adjust the flame

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
15. List the steps in turning off oxy-acetylene equipment.	Discuss and demonstrate the sequential steps to turning off oxy-acetylene equipment. Have students practice these procedures.	Turning-Off Steps 1. Close acetylene torch valve 2. Close oxygen torch valve 3. Turn off acetylene cylinder valve 4. Turn off oxygen cylinder valve 5. Open acetylene torch valve 6. Open oxygen torch valve 7. Turn acetylene regulator screw counterclockwise 8. Turn oxygen regulator screw counterclockwise 9. Close acetylene and oxygen torch valves
16. Identify equipment required for oxy-acetylene cutting.	Have students recognize equipment required for oxy-acetylene cutting.	Oxy-acetylene Cutting Equipment 1. Oxy-acetylene welding equipment 2. Cutting torch
17. Demonstrate safe procedures in cutting with oxy-acetylene equipment.	Explain the uses of oxy-acetylene cutting in the power mechanics area. Review uses such as: . to cut bolts . to cut rivets . to cut frame components . to cut panel assemblies . to cut pipe (exhaust & mufflers) Emphasize safety precautions and have students practice setting up the oxy-acetylene equipment for simple welds and cutting procedures.	

USE OF MANUALS (PM101-04)

Major Objective: To develop a student's ability of obtaining accurate information through the use of manuals.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Recognize the importance of accurate information with regard to power mechanics.	Emphasize the importance of locating accurate data, particularly with regard to the wide range of specifications in the power mechanics field.	
2. Demonstrate the necessary skills in using indexes with manuals.		
3. Locate instructions and specifications in a manual.	Have students select a component repair section and list the disassembly and assembly procedures and the specifications required.	
4. Read a specification sheet in a lab manual.	Have students locate a specification sheet in a current shop manual and explain its contents.	
5. Recognize the importance of keeping a manual clean.	Emphasize that shop manuals are a necessary part of a power mechanics lab. Manuals are the most reliable source of information and should be kept clean for constant reference.	

THEORY OF ENGINE OPERATION (PM101-05)

Major Objective: To enable the student to understand the theory, principles, components and operation of internal combustion, 2- and 4-stroke cycle, and other experimental engines.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. INTRODUCTION The student should be able to:		
1. Define engine.	Have students define engine. Point out that an engine acts as a power plant for an auto- mobile and consists of systems and components assembled in a specific order to convert energy into a useful form.	Engine Any mechanical contrivance which converts sources of energy into usable effort.
2. Identify basic types of engines.	Introduce students to the basic types of engines.	Types of Engines 1. Internal combustion 2. External combustion
3. Demonstrate an understanding of the principles of engine operation.	Point out that the internal combustion engine burns fuel within the cylinders and converts the expanding force of the combustion, or "explosion", into a mechanical force used to propel the vehicle. Explain that the external combustion engine burns fuel in an open area, and that heat from combustion is used to produce a secondary source of energy (e.g., steam engine).	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. ENGINE CLASSIFICATION The student should be able to:		
1. Define work, energy, power, horsepower, torque.	Have students define and discuss the relationship among work, energy, power, torque and horsepower. Give examples of each.	Work The moving of an object against an opposing force. Work = distance x force. Energy The ability or capacity to do work. Power The rate or speed at which work is done. Horse Power The measurement of an engine's ability to perform work. The ability to lift 33,000 pounds one foot in one minute equals one horsepower. Torque A twisting or turning effort which may or may not result in motion.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify methods of classifying engines.	Use visual aids and/or models and point out the types of internal combustion engines: . two- and four-cycle reciprocating . gas turbines . free piston . rotary	Methods of Classifying Engines 1. Number of cylinders 2. Arrangement of cylinders 3. Arrangement of valves 4. Type of cooling systems 5. Type of cycles 6. Type of fuel used
3. Explain the firing order of an engine.	Point out to students that crankshaft design and valve trains operations will determine firing order, which provides a smooth engine operation. Use transparencies, charts and reference material to show students various crankshaft configurations with valve positions, piston movement, strokes and firing order.	
4. Explain an engine's power rating.	Discuss and compare the relationship among indicated horsepower, brake horsepower and SAE power. Point out that under SAE specifications, gross brake horsepower rating is the maximum horsepower developed by an engine equipped with only basic accessories needed for its operation; i.e., emission controls, oil, fuel pump, coolent pump.	Indicated Horsepower (ihp) The theoretical power an engine is able to produce--a measure developed by the burning fuel within the cylinders. Brake Horsepower (bhp) A measurement of the actual usable horsepower delivered at the engine crankshaft. Bhp increases with speed.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	Net horsepower rating is the maximum horsepower developed by the engine when equipped with all accessories, such as fan, alternator, muffler, catalytic converter, fuel pump, coolent pump, air cleaner, etc., that it would have when installed in the car.	SAE Power The power of an engine as determined by the society of automotive engineers. SAE power is measured at the transmission output shaft with all normal engine accessories mounted and operating.
C. INTERNAL COMBUSTION ENGINE The student should be able to:		
1. Demonstrate the understanding of basic principles of an internal combustion engine.	Point out that the modern automobile uses an internal combustion engine, which converts the potential energy contained in the fuel to heat energy inside the cylinders. As the hot, expanding gases push against the pistons the heat is then converted into mechanical energy which is used at the flywheel.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Demonstrate familiarity with the terms which describe the mechanical, operational, and power features of an internal combustion engine.	Provide students with the terms used in describing engine performance. Use transparencies, filmstrips, charts, and models with assigned contract sheets for various specification measurement and calculation.	Top Dead Centre (TDC) The farthest point of upward travel of the piston in a cylinder. Bottom Dead Centre (BDC) The lowest point of downward travel of the piston in a cylinder. Bore Inside diameter of a cylinder. Stroke The distance travelled by the piston from TDC to BDC.
3. Identify engine cycles.	Relate the definition of cycle to the operation of two- and four-stroke cycle engines. Using charts and models, demonstrate the operation of two- and four-stroke cycle engines.	Engine Cycle Strokes 1. Intake 2. Compression 3. Power 4. Exhaust
4. Explain the engine cycles.	Discuss with students and compare the construction and operation of two- and four-stroke cycle engines.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Name the various parts of a simple internal combustion engine and their relationship to one another.	Use visual aids and/or models to acquaint students with the basic components of the different types of internal combustion engines.	Basic Parts of a Simple Combustion Engine 1. Cylinder block 2. Pistons 3. Connecting rods 4. Crankshaft 5. Cam shaft 6. Valves (intake and exhaust) 7. Cylinder head(s) 8. Timing chain or gears 9. Flywheel
6. Explain the need for and application of lightweight materials.	Discuss points such as inertia, economics, efficiency, and weight vs horsepower, as these relate to automobiles.	
7. Explain the need for improved replacement parts and materials.	Discuss how initial design problems and technology of new materials has brought about changes to replacement parts.	
8. Explain engine assembly and disassembly procedures.	Demonstrate disassembly and assembly procedures. Provide students with a procedural check list.	
9. Disassemble, inspect and assemble a 2- and 4-stroke cycle engine.	Have students complete a record after each step of disassembly, inspection and assembly of both two- and four-stroke cycle engines.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Describe rotary-engine operation.	Use visual aids, charts and/or models to demonstrate rotary-engine operation. Have students identify present uses of rotary-engine operation.	
11. List other experimental engines.	Have students compare the operating principles of other types of internal combustion engines. Have students do magazine research and prepare charts on other experimental engines.	
		Experimental Engines 1. Gas turbine 2. Sterling 3. Free piston 4. Jet 5. Racing engines

LUBRICATION SYSTEMS, LUBRICANTS AND BEARINGS (PM101-06)

Major Objective: To develop a student's understanding of the importance of lubrication and the types of lubrication systems, lubricants and bearings used in the transportation field.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. LUBRICATION The student should be able to:		
1. Define friction.	Point out that friction is not constant but depends on the type of surface and on the pressure holding two objects together, and that is it impossible to completely eliminate friction.	Friction Resistance to movement between two objects when placed in contact with each other.
2. Explain the function of the lubrication system.	Have students prepare a list identifying the types and functions of lubricants. Emphasize that without lubrication moving parts would wear away and cause seizure.	Function of Lubrication System 1. To minimize wear 2. To minimize power loss from friction 3. To act as a cooling agent 4. To absorb shocks and reduce engine noise 5. To form a seal between piston rings and cylinder walls 6. To act as a cleaning agent
3. Identify the different types of lubrication systems.		Types of Lubrication Systems 1. Splash 2. Pressure 3. Combination splash and pressure 4. Mixture of fuel and oil 5. Fuel and oil injection

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. List the types of oil pumps.	Acquaint students with the various types of pressure pumps for lubrication systems.	Types of Oil Pumps 1. Rotary 2. Gear 3. Vane 4. Plunger
5. Identify the types and composition of lubricants.	Discuss how different weights of lubricants perform under different temperature conditions. Acquaint students with the various types of lubricants. Explain where greases and/or liquid lubricants are used.	Types of Lubricants 1. Oil-Petroleum, Synthetic 2. Grease 3. Graphite 4. Silicone 5. Molebdenum
6. List the jobs a lubricant must perform.		Lubricant Jobs 1. Clean 2. Cool 3. Seal 4. Lubricate 5. Reduce noise 6. Cushion
7. Describe oil classification systems.	Point out to students that classifications were laid down by the American Petroleum Institute and Society of Automotive Engineers to group different types of oils according to specific operating conditions.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Explain the purpose of oil additives.	Review and discuss the following: . corrosion inhibitors . anti-scuff additives . oxidization inhibitors . detergent dispersants . viscosity improvers . pour-point depressants . foam inhibitors	
9. List advantages and disadvantages of synthetic oil.	Explain that synthetic oils are chemically compounded and that they do possess certain benefits and advantages over petroleum oil.	Advantages of Synthetic Oil 1. Less frequent oil changes 2. Reduced wear 3. Viscosity stability 4. Increased fuel economy Disadvantages of Synthetic Oil 1. Expensive 2. May cause oil consumption, when switching from petroleum base oil
10. Explain the purpose of oil filters.	Emphasize that oil filters prolong the life of an engine by removing: . trapped dust . deposits . carbon particles . metallic pieces	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. List the types of filtration systems.	Explain the difference between the full-flow and the bypass filtration systems.	Types of Filtration Systems 1. Full-flow 2. Bypass
12. Identify types of oil filters.	Discuss materials used in the oil filter cartridge and the built-in safety devices which ensure lubrication at all times.	Types of Oil Filters 1. Spin-on 2. Removable element
13. Identify tools and equipment for servicing/lubricating engines and chassis.	Emphasize that proper tool selection will improve both the quality and speed of any repair operation.	
14. Identify common lubrication problems and provide solutions.	Discuss the importance in complying with manufacturers' recommendations and other variables which must be taken into consideration, i.e.: . frequent starts and stops . short driving distance . no warm up . operation in dusty conditions . operation in severe temperatures	
15. Perform lubrication system services.	Emphasize the importance of regular maintenance, pointing out how it prolongs engine life. Demonstrate the proper procedures required to perform an oil change and chassis lubrication.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. BEARINGS		
The student should be able to:		
1. List the classes of friction.	Discuss with students the classes of friction and the applications of: . wet rolling (transmission) . dry sliding (brakes) . wet sliding (cam shaft)	Classes of Friction 1. Dry 2. Wet
2. Explain the purpose of bearings.	Have students discuss the purpose for bearings. Emphasize that bearings reduce friction of rotating parts and are classified into two basic groups: friction and anti-friction.	
3. List and describe the types of bearings.	Have students prepare a report on various designs of bearings.	Types of Bearings 1. Anti-friction a) ball b) roller c) tapered roller d) needle 2. Friction a) bushings

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FUEL SYSTEMS (PM101-07)

Major Objective: To develop a student's understanding of automotive fuel sources, fuel systems and the fundamental principles of carburetion.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. FUELS & FUEL SUPPLY SYSTEMS The student should be able to:		
1. Identify types of fuels.	Have students summarize how crude oil is converted into gasoline, diesel fuel, liquid propane gas and other products.	Types of Fuels 1. Gasoline 2. Diesel 3. Alternate
2. Describe properties of gasoline and diesel fuel.	Point out that extra chemicals, called additives (lead, detergents, antioxidants, etc), are mixed into gasoline to improve its operating characteristics. Explain that a litre of diesel fuel contains more energy than a litre of gasoline.	
3. Describe the purpose of the fuel system.	Point out that all grades of gasoline are octane rated while diesel fuel is cetane-rated; i.e., the higher the octane rating, the slower the burning; the higher the cetane rating, the faster the burning. Have students summarize several factors that control engine octane requirements.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. List alternate automotive fuels.	Have students prepare a list and discuss the characteristics and properties of alternate automotive fuels.	Alternate Fuels 1. LP-Gas (Liquified Petroleum) 2. Ethyl Alcohol (Ethanol) 3. Methyl Alcohol (Methanol) 4. Gasohol 5. Hydrogen 6. Synthetic fuels
5. Define fuel system.	Discuss the units of the fuel system which include the fuel tank, filters, lines, fuel pump, carburetor, air cleaner, intake manifold and the exhaust system.	Fuel System Component parts which store, transfer, and proportion fuel with air necessary for proper combustion at varying engine speeds.
6. Identify types of fuel systems.	Use visuals and models to acquaint the students with and explain the types of fuel systems.	Types of Fuel Systems 1. Carburetor 2. Gasoline injection 3. Diesel injection
7. Describe the purpose of the fuel system.	Point out these purposes for the fuel system: . to provide the correct amount of air and fuel to the engine under all operating conditions and power demands; . to provide fuel enrichment under certain conditions and compensate for high-altitude operation.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Identify components of the fuel-supply system.	Have students locate and name the components of a fuel system. Use transparencies, filmstrips, charts and models.	Components of the Fuel-Supply System 1. Fuel tank 2. Fuel lines 3. Fuel pump 4. Fuel filters
9. Describe how fuels affect engine performance.	Point out that for top performance and good fuel economy, a gasoline should provide the following: . good gas mileage . fast starts . rapid warm-up . quick acceleration . smooth performance . minimum engine maintenance	
10. Identify problems related to abnormal combustion.	Explain to students that lean air fuel mixtures, high operating temperatures, and low octane unleaded fuels of today make abnormal combustion a major problem. Review the concept of detonation and preignition.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. Identify problems related to diesel fuel systems.	Point out that many of the components of this system are highly finished and operate with clearances as small as .0001 inch (.00254mm). Foreign material in the system can damage these parts and/or impair engine performance. Acquaint students with summer and winter diesel fuels.	
12. Identify types of emission-control systems.	Use transparencies and charts to familiarize students with the various types of emission-control systems.	Types of Emision-Control Systems 1. Positive Crankcase Ventilation (PCV) 2. Evaporative Control (ECS) 3. Exhaust Gas Return (EGR) 4. Air Injection 5. Aspirator Air 6. Catalytic Converter 7. Liquid Fuel Control
B. CARBURETORS		
The student should be able to:		
1. Identify types of carburetors.	Using transparencies, charts and models, familiarize students with different types of carburetors and their variations.	Types of Carburetors 1. Down draft 2. Up draft 3. Side draft
2. Summarize carburetor operating principles.	Discuss with students that the carburetor is designed to take advantage of the principles	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
	of pressure differences and venturi action to satisfy performance and economy requirements as well as emission standards.	
3. Identify basic parts of a carburetor.	Using transparencies, charts amd models, have students locate and name the basic parts of a carburetor.	Basic Parts of a Carburetor 1. Carburetor body 2. Air horn 3. Throttle value 4. Venturi 5. Fuel bowl 6. Main discharge nozzle
4. Diagnose common carburetor problems.	Emphasize the use of a systematic approach when trying to locate performance problems. Discuss carburetor problems such as: . air/fuel mixture . choke adjustment . flooding . acceleration system problems	
5. Perform basic external carburetor adjustments.	Demonstrate basic external carburetor adjustments and explain the effect on engine performance.	
6. Describe the operation of computer-controlled carburetors.	With the aid of charts and illustrations, provide students with a general overview about various sensors and their purpose in a computer-controlled carburetor system.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
C. FUEL-INJECTION SYSTEM The student should be able to:		
1. Define fuel injection.	Discuss the fuel-injection system.	Fuel Injection A system that uses no carburetor but sprays fuel either directly into cylinders or into the intake manifold.
2. Describe fuel injection.	Use transparencies, filmstrips, and charts to enable students to identify the types and classifications of fuel-injection systems. Acquaint students with the different designs of fuel-injection systems and discuss their advantages.	
3. Identify variations of fuel-injection systems.		Variations of Fuel-Injected Systems 1. Combustion chamber 2. Port injection 3. Constant flow 4. Timed injection
4. List advantages of fuel injection.	Discuss possible advantages of an injection system over a carburetor-type fuel system; ie: . improved fuel economy . better fuel distribution . smoother idle . lower emissions	

COOLING SYSTEMS (PM101-08)

Major Objective: To enable the student to recognize various cooling systems, to understand how they function and to develop skills necessary for general maintenance and repair.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Identify safety requirements with regard to cooling systems.	Emphasize precautions to follow when working with a cooling system. A hot cooling system is pressurized and can boil or overflow when the radiator cap is removed.	
2. Identify the need for a cooling system.	Have students define cooling system. Emphasize that without the cooling system, the engine would seize from excessive heat. Discuss the sources of heat within an engine; i.e., combustion, friction, heat of compression.	Cooling System A system, air or liquid, designed to remove excess heat from the engine.
3. List the functions of the cooling system.	Emphasize to students that for a cooling system to function properly, it must be maintained regularly.	Functions of Cooling System 1. Reach normal running temperature as soon as possible 2. Maintain operating temperature 3. Get rid of excess heat
4. Identify the types of cooling systems.	Have students explain the advantages and disadvantages of the different types of cooling systems. Have students prepare charts to identify cooling systems.	Types of Cooling Systems 1. Liquid 2. Air

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Describe the difference between an air-cooled and a liquid-cooled engine.		
6. List the parts within a liquid-cooled system.	Emphasize to students the importance of internal design in liquid-cooled systems for efficient liquid flow. Explain the importance of a water pump and how its parts function.	Liquid-Cooled System Components 1. Rad and cap 2. Rad hoses 3. Water pump 4. Water jacket 5. Thermostat 6. Belts and pulleys 7. Overflow tank 8. Shroud 9. Electric fans 10. Spray nozzles 11. Distribution tubes
7. Explain the function of the parts of a liquid-cooled system.		
8. List the types of radiators.		Types of Radiators 1. Cross or side flow 2. Down flow

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. List the parts of a radiator.	Point out the importance of transmission coolers in radiators.	Parts of a Radiator 1. Upper holding tank 2. Lower holding tank 3. Core
10. Explain the purpose of a shroud.	Show how the shroud prevents recirculation of air and acts as a guard for safety.	
11. List the parts within an air-cooled system.		Air-Cooled System Components 1. Cooling fins 2. Shroud 3. Thermostatically controlled shutter 4. Belts
12. Explain the function of the parts of an air-cooled system.	Have students prepare a list of the parts within an air-cooled system and explain the purpose of each part.	
13. List the types of fans.		Types of Fans 1. Standard fan 2. Flex fan 3. Thermo-clutch fan 4. Combination thermo-clutch flex fan 5. Thermostatic control electric fan

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
14. Inspect and diagnose problems related to a cooling system.	Demonstrate and have students follow procedures for performing minor cooling system repairs: . testing coolant . replacing belts and hoses . replacing thermostats . testing radiator cap pressure . testing radiator pressure . flushing cooling systems	
15. Identify special tools to service cooling systems.	The use of special tools is necessary to prevent damage to the cooling system.	Special Tools 1. Hose clamp pliers - "Shark Tooth" 2. Pressure tester 3. Offset fan wrench 4. Flush kit
16. Perform general repair and maintenance on cooling systems.	Have students diagnose, repair, and test cooling systems whenever problems are encountered.	

BASIC ELECTRICAL SYSTEM PM101-09

Major Objective: To provide students with a basic understanding of the principles of electricity and to develop an understanding of electricity and electronics applications to the automobile.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. BASIC ELECTRICITY The student should be able to:		
1. Define voltage, current, resistance.	Emphasize to students that working knowledge of the basic principles of electricity is essential for a safety check, routine tune-up or the actual repair of an electrical circuit.	Voltage Difference in electrical potential between one end of a circuit and the other. Voltage causes current flow. Current Movement of free electrons through a conductor. Resistance Measure of a conductor's ability to retard flow of electricity.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. State Ohm's Law.	Discuss and compare the relationship of Ohm's Law and Power Law to the electrical system. Point out that Ohm's Law states the relationship between current, voltage and resistance in a dc circuit whereas the Power Law is used to find the wattage rating of circuit parts, the value of current in a circuit, and the cost of operating electrical and electronic products.	Ohm's Law 1. Amperes equals volts divided by ohms ($I=\frac{E}{R}$). 2. Volts equals amperes multiplied by ohms ($E=I \times R$). 3. Ohms equals volts divided by amperes ($R=\frac{E}{I}$). Power Law 1. Power in watts equals voltage multiplied by the current ($P=E \times I$). 2. Voltage equals power in watts divided by current ($E=\frac{P}{I}$). 3. Current equals power in watts divided by voltage in volts ($I=\frac{P}{E}$).
3. Solve problems using the three forms of Ohm's Law.		Ohm's Law $I = \frac{E}{R}$ $E = I \times R$; $I = \frac{E}{R}$ $R = \frac{E}{I}$

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Define series circuit.	Discuss with students series and parallel circuitry, identifying the application of each in power mechanics.	Series Circuit Two or more resistances that are so wired that the current has only one pathway.
5. Define parallel circuit.		Parallel Circuit Two or more resistances connected in such a way that current can pass through all units at once, or through any one of them independent of the other.
6. Draw and construct series and parallel circuits.	Have students build electrical boards and describe series and parallel circuit flow.	
B. BATTERIES		
The student should be able to:		
1. Explain the purpose of a battery.	Have students report on the purpose of a battery. Emphasize these purposes: . to provide electrical energy to the starting, ignition, lighting and accessories system; . to act as a voltage stabilizer for any abnormal stray voltages created by the electrical system.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Identify types of batteries.	Discuss and compare the construction and advantages of maintenance-free batteries.	Types of Batteries 1. Dry charged 2. Wet charged - freedom battery
3. Describe the construction and operation of batteries.	Using cutaways and charts, have students describe the construction of batteries. Emphasize these principles: . a battery converts chemical energy into electrical energy; . there are two theories about the direction of electric current; . common practice in the auto trade area is to accept the positive side as the live side.	
4. Identify battery testing and charging procedures.	Point out the procedures and the need to follow safety precautions when servicing batteries.	
5. Perform procedures safely in testing and charging a battery.	Discuss the importance of specific gravity readings which indicate whether a battery is serviceable or non-serviceable. Have students test and charge batteries. Note: - Never charge a frozen battery (likelihood that the battery will burst when charged.) - Never boost a computer-controlled system vehicle (likelihood that surges will damage computer circuitry.)	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Identify tools and equipment required for battery testing and maintenance.	Discuss with students the use of proper tools and equipment for battery maintenance.	Tools and Equipment 1. Post cleaner 2. Battery post clamp remover 3. Battery charger 4. Hydrometer
C. AUTOMOTIVE CIRCUITS		
The student should be able to:		
1. Identify basic components in an auto wiring circuit.	Have students illustrate the basic components and paths of electricity, labelling and describing their functions. Have students design a model circuitry board.	
2. Identify circuit protection devices.	Emphasize the importance of circuit protection devices to safeguard component parts from extensive damage.	Circuit Protection Devices 1. Fuse 2. Fusible link 3. Circuit breaker
3. Identify tools and equipment required for circuit testing.	Demonstrate and have students use the procedures for detecting and repairing minor faults in the electrical system.	
4. Test and repair electrical circuits.	Emphasize safety and correct use of tools.	

BASIC IGNITION SYSTEM (PM101-10)

Major Objective: To provide students with an understanding of the basic operation of contact point and electronic ignition systems.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. CONVENTIONAL IGNITION SYSTEM The student should be able to:		
1. Identify the safety aspects related to the ignition system.	Emphasize safety precautions, cleanliness and the proper use and care of the required tools and equipment. Caution students to repair the ignition system only when the ignition switch is off.	
2. Define ignition system.	Have students discuss and define ignition system.	Ignition System A group of related components which produce high-voltage surges of current to ignite the air/fuel mixture.
3. List the types of ignition systems.	Use visual aids (mock-ups) to describe the various ignition systems.	Types of Ignition Systems 1. Conventional 2. Electronic 3. Magneto

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Identify the components of the primary circuit.	Have students locate and name the components of the primary ignition system circuits.	Parts of Primary Circuit 1. Battery 2. Ignition switch 3. Ballast resistor 4. By-pass wire 5. Primary side of coil 6. Points/Electronics pickup 7. Condenser 8. Ground side of spark plugs
5. Identify the components of the secondary circuit.	Have students locate and name the components of the secondary ignition circuit. Contact various power mechanics distributors and service departments for professional charts, manuals, diagrams, etc.	Secondary Circuit 1. Secondary side of coil 2. High tension wires 3. Distributor cap 4. Rotor 5. Center electrode of spark plug
6. Explain the function of the ignition system components.	Have students describe the function and importance of each component part as it relates to the conventional ignition system.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. MAGNETO		
The student should be able to:		
1. Identify the components of a magneto ignition system.	Use transparencies, diagrams, filmstrips and demonstrations to enable students to locate and explain the component parts of a magneto ignition system.	Magneto System 1. Magneto fly wheel 2. Pole shoes - N & S 3. Coil 4. Breaker points 5. Condenser 6. High tension wire 7. Spark plug(s)
2. Explain the function of the components of a magneto ignition system.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
C. ELECTRONIC IGNITION SYSTEM The student should be able to:		
1. Identify the components of the electronic ignition system.	Use transparencies, filmstrips, charts and demonstrations to enable students to locate and explain the purpose of the components in an electronic ignition system. Point out that the electronic ignition system has essentially the same components as the contact point system. In addition, the electronic ignition system has an electronic control unit. Instead of contact points, the electronic ignition distributor has a magnetic pulsing system which signals the electronic control unit.	Electronic Ignition Components 1. Battery 2. Ignition switch 3. Ignition distributor 4. Ignition coil 5. Wiring 6. Spark plugs 7. Electronic control unit
2. Explain the function of electronic ignition system components.	Familiarize students with computer control.	
3. List advantages of an electronic ignition system.	Point out that an electronic ignition system requires little maintenance and is much more efficient than the older contact ignition system. There is less misfiring, and consequently better performance and emissions control.	Advantages of an Electronic Ignition System 1. Precise control of timing 2. Better economy 3. Less emissions 4. Less wearing parts 5. A good spark at high R.P.M.'s 6. Less maintenance

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
D. TUNE-UP		
The student should be able to:		
1. Explain the need for a tune-up.	Emphasize to students that regular engine tune-ups are required to provide for peak engine performance and good gas mileage.	
2. Identify components to be checked in performing a tune-up.	Have students list the items to be checked or serviced in performing a tune-up.	
3. Explain the need for advanced timing.	Demonstrate to students how vacuum advance and mechanical advance affects initial timing. Have students adjust the timing on an engine if possible.	
4. Draw a contact point and electronic ignition schematic and label the parts.	Have students point out the difference between a conventional contact point and an electronic ignition system.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Identify tools and equipment required in performing a tune-up.	Alert students to the special tools and equipment required in performing a tune-up. Acquaint students with visual inspection tests, and use transparencies, charts and manuals enabling students to describe basic diagnostic and tune-up procedures.	Tune-up Equipment 1. Dwell meter 2. Tach meter 3. Volt meter 4. Timing light 5. Ignition wrenches
6. Perform a minor tune-up.	Have students tune-up an engine which has been set out of tune by contrivance, or through wear and use.	

WHEELS, HUBS AND TIRES (PM101-11)

Major Objective: To provide students with an understanding of the design and functions of wheels, hubs and tires.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. WHEELS		
The student should be able to:		
1. Describe the need for wheels/hubs.	Point out that the wheel of a vehicle consists of a tire and rim, and is attached to the flanges of the axle shafts. The hub is part of the brake drum, or houses the brake drum assembly, which is a necessary component to vehicle control.	
2. List the types of rims used today.	Use transparencies to acquaint students with types, designs and construction of wheels/rims.	Types of Rims 1. Cast 2. Stamped
3. Describe wheel design.	Point out that the most common type of wheel in use today is the drop-centre steel disc-type wheel. The inner section forms the disc or wheel and is either riveted or welded to the outer section, the rim.	Wheel Designs 1. Drop centre/steel disc 2. Spokes 3. Split rims - 2 piece - 3 piece

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Demonstrate safe maintenance practices as they relate to wheels, hubs and tires.	Discuss with students the following safety practices: . rotate tires regularly . balance wheel and tire assemblies . check and maintain correct tire pressures . check for rusted or dented rim flanges . inspect regularly for loose lug nuts . ensure that load range specifications are not exceeded . check tire tread wear	
B. TIRES		
The student should be able to:		
1. Explain the need for tires.	Some laboratories will be unable to have students experience hands-on learning in this section. Point out that the tire and wheel assembly provide the only connection between the vehicle and the road. Tires must support the vehicle, cushion road shock, transmit power, provide friction for braking, absorb forces generated by fast cornering, and maintain traction in all conditions.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
2. Explain tire sizes.	Point out the tire-load classification system and with examples, have students read and explain tire markings.	Common Tire-Load Classifications A = 2/4 ply rating B = 4 ply rating C = 6 ply rating D = 8 ply rating
3. Identify tire construction and types of tires.	Use transparencies and other visual aids to explain tire types, construction, and tread design. Explain how tread design affects performance; i.e., all-season tires, winter tires, rain tires, etc.	Types of Tires 1. Bias-ply 2. Bias-belted 3. Radial-ply
4. Explain the importance of proper tire inflation.	Discuss with students the following: . tire pressure should be checked when tires are cold . tire pressure should conform to the manufacturers' specifications . tire pressure should be checked regularly	
5. Demonstrate how to remove a tire from a rim.	Demonstrate proper tire removal procedures.	
6. Demonstrate how to replace a tire on a rim.	Point out the importance of clearing rim flanges for proper bead sealing. Clean rims with a wire brush and check for leaks after assembly.	

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
7. Explain the need for tire balancing.	Discuss the effects of unbalanced tires; i.e.: . poor ride . excessive tire wear . steering unit wear . suspension unit wear Have students define the following: 1. Wheel Tramp (tire and wheel hopping up and down) 2. Wheel Shimmy (Shaking from side to side)	
8. Explain static and dynamic balance.		
9. Identify tools and equipment for tire balancing.		Tools for Tire Balancing 1. Tire balancer 2. Lead weights 3. Tire balancing pliers 4. Taped weights
10. Explain the recommended tire rotation for given vehicles.	Point out that tires should be rotated every 8000 km (5000 miles) and that the best time for tire inspection is during tire rotation. Explain the proper tire-rotation sequence for radial tires and bias ply tires.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. Identify tire-wear problems.	Point out that overinflation results in a harsh ride and centre tread wear, and that underinflation causes increased rolling and fuel consumption, hotter running tires, difficult steering and wear on outer tread edge. An improper wheel alignment will cause excessive tread wear.	

power mechanics 201

POWER MECHANICS 201

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STUDENT ORIENTATION AND SAFETY (PM201-01)

Major Objective: To enable the student to explore and relate the significance of power mechanics to the needs of individuals, industry and society, and to develop safe practices and competency in the use of tool machines and processes.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. STUDENT ORIENTATION		
The student should be able to:		
1. Outline the historical development of power mechanics.	Discuss the historical development of automotive construction from the era of the horseless carriage to the present.	
2. Demonstrate an awareness of the modules in Power Mechanics 201.	Use transparencies, charts, handouts to provide students with information about the various modules to 201 Power Mechanics. Discuss with students the goals which are common to all programs in Industrial Arts. Provide students with a course outline and evaluation procedures. Have students prepare and maintain a notebook as an ongoing project.	
3. Demonstrate an understanding of the course requirements for 201 Power Mechanics.	Refer to the course outline, and discuss the topics to be covered.	

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. SAFETY The student should be able to:		
1. Demonstrate an understanding of the need for safety and safety equipment.	Discuss the contribution of knowledge, skills and positive attitudes to safe living and working conditions in homes, schools and communities.	Safety Equipment 1. Safety glasses 2. Footwear 3. Guards on equipment 4. Ear plugs 5. Hard hats 6. Gloves
2. Demonstrate an understanding of safety standards as they apply to the power mechanics lab.	Make students aware of the importance of orderliness and safety in power mechanics. Conduct shop/lab tour(s), noting the location and purposes for various safety equipment.	
3. Describe procedures to be followed in the power mechanics lab.	Discuss the importance of safety behaviour and practices. Although safety is an ongoing process, a safety pre-test should be conducted before students participate in shop/lab activities.	
4. Demonstrate safe habits.	Have students list and assess the consequences of unsafe acts related to persons, materials, tools, and equipment. Point out that good housekeeping practices aid in preventing accidents as well as in providing a pleasant, well-organized environment for work and learning.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. List hazardous conditions in the power mechanics lab.	Emphasize the importance of safety rules. Explain and demonstrate the ABC of Safety: "Always Be Careful." Have students accept responsibility for daily routine procedures and safety inspections.	Sources of Potential Danger 1. Hand tools 2. Compressed air 3. Power tools/equipment 4. Jacking devices 5. Hoists 6. Jack stands 7. Hot metal 8. Co-venting 9. Welding equipment
6. Identify emergency procedures.	Make students aware of emergency procedures related to first aid, fire and accidents. Note location of eye wash station(s), power switches, alarms and panels. Have students rehearse emergency procedures.	
7. Demonstrate an understanding of the use of fire extinguishers.	Discuss the different types of fire extinguishers and their limitations. Discuss the location, and demonstrate the use of a fire extinguisher. Review and practice emergency procedures for leaving the shop/lab.	
8. Demonstrate an understanding of accident reporting procedures.	Establish a procedure for reporting all accidents, no matter how trivial. Explain reporting procedures and the purpose for accident report forms. Record health problems students might have.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Wear apparel appropriate for a power mechanics lab.	Discuss the relationship of clothing and other protective devices to the work being done. Point out the hazards associated with loose clothing, jewellery, long hair and long sleeves. Discuss and demonstrate methods of sanitizing protective devices. Eye protection should be a requirement in a power mechanics shop/lab.	
10. Demonstrate proficiency in safety.	Conduct regular safety tests to monitor the students' proficiency with regard to various shop activities.	

ENGINE TYPES (PM201-02)

Major Objective: To provide the student with an understanding of the different types of engines and their advantages, disadvantages and applications.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Describe the differences between a two- and four-stroke cycle engine.	Make students aware of the construction and operation of two- and four-stroke cycle engines. Use charts, filmstrips, transparencies and models to demonstrate the operation of two- and four-stroke engines.	Engine Cycle Systems 1. Intake 2. Compression 3. Power 4. Exhaust
2. List the advantages of two- and four-stroke cycle engines.	Point out that engines have various systems in order to perform efficiently one complete engine cycle. Point out that the two-stroke cycle engine has several advantages that have made it popular for small engine application--outboard motors, chain saws, lawn mowers, go-carts, etc.	
3. Identify various applications of a two- and four-stroke cycle engine.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Describe rotary (Wankel) engine operation.	Use transparencies, charts, filmstrips, etc., to acquaint students with the rotary engine operation. Emphasize features such as: no reciprocating motion; fires twice as often per rotor as the cylinders of a standard engine; smaller and lighter; less vibration; more horsepower than a reciprocating engine of comparable size.	
5. Demonstrate an understanding of rotary engine construction.	Point out the three moving parts in the two-rotor engine: the eccentric shaft, and the two rotor assemblies.	
6. Describe diesel engine operation.	Point out that heat produced by the compressions ignites the fuel, eliminating the need for spark plugs or a separate ignition system and a carburetor.	
7. Demonstrate an understanding of diesel engine construction.	Point out that diesels can operate on either the two-stroke or four-stroke principle. Emphasize that because of high compression ratio, the parts construction must be more durable than that of the conventional engine.	
8. Describe K-cycle engine operation.	Use charts and transparencies to describe the operation and construction of the K-cycle engine.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Demonstrate an understanding of K-cycle engine construction.		
10. List the various valve arrangements.	Use visual aids and cutaways to explain the differences in valve arrangements.	Valve Arrangements 1. I - head 2. F - head 3. L - head 4. T - head
11. Identify the methods of two-stroke cycle valving.		Methods of Valving 1. Piston port 2. Rotary valve 3. Reed valve
12. Describe the effect valve position has on the combustion chamber.	Emphasize the importance of valve location to horsepower and fuel economy. Emphasize that the opening and closing of the valves must be timed and that valves must be sealed during segments of the combustion cycle.	
13. List the types of valve trains.	Using visual aids, point out the various designs and locations of valve train assemblies. Discuss various valve train drives; i.e., standard chain, standard gear, overhead chain and overhead cogged belt.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
14. Identify the different types of combustion chamber designs.	Emphasize that combustion chamber design is important in producing high compression ratios without the occurrence of damaging detonation and the reduction of emissions.	Types of Combustion Chambers 1. Wedged 2. Hemispherical 3. Domed 4. Wankel 5. Precombustion
15. List the types of cylinder arrangements.	Point out the importance of cylinder arrangement with regards to block distortion, tortional vibration, crankshaft length, and the reduction of block length.	Types of Cylinder Arrangements 1. Radial 2. Straight (in-line) 3. Opposed or flat 4. V-Block
16. Explain the differences in cooling system applications.	Have students report on examples of cooling system applications. Discuss advantages and disadvantages.	
17. List various fuel classifications.	Review the purpose of the fuel system with reference to engine performance and needs.	Fuel Classifications 1. Gasoline - leaded, non-leaded, and gasohol 2. Diesel - summer and winter 3. Propane 4. Other (e.g., methane)

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
18. Identify other experimental engines.	Have students prepare a report on the different adaptations of experimental engines at the present time.	Experimental Engines 1. Gas turbine 2. Stirling 3. Free piston 4. Jet 5. Racing engines 6. Electric & hybrid power
19. Explain the operating principles of experimental engines.	Have students compare the operating principles of experimental engines by using diagrams, posters, and manuals, by examining engine parts, visiting industries, by experimenting, etc.	

ENGINE TEST AND MEASUREMENT (PM201-03)

Major Objective: To provide students with an understanding of the many different methods employed in determining engine efficiency.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Define horsepower.	Emphasize that a number of factors determine an engine's ability to produce usable power for efficient performance, and that various engine measurements are established by manufacturers to satisfy performance requirements. True horsepower is measured at the driving wheels of a vehicle.	Horsepower The foot-pound unit of mechanical power, once used to measure the rate at which work was done. One horsepower equals 33,000 ft. lbs. of work per minute. Today, power is measured in watts. One horsepower is equal to 746 watts.
2. Understand measurement of horsepower.		
3. Demonstrate an understanding of thermal efficiency.	Explain that heat generated by the burning fuel produces the power stroke. However, much of this heat is lost to the cooling system, lubricating system, and exhaust system. With these losses, an engine's efficiency is then dropped to approximately 20%.	Thermal Efficiency The energy used to produce useful horsepower.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Define mechanical efficiency.	Explain that mechanical efficiency is seemingly high because frictional losses within the engine are minimal.	Mechanical Efficiency The relationship of power developed within the engine and brake horsepower delivered at the crankshaft.
5. Define indicated horsepower.	Discuss the factors involved in arriving at a horsepower rating: size of vehicle, transmission, and accessories.	Indicated Horsepower (ihp) A measure of power developed by the burning fuel within the cylinders.
6. Define brake horsepower.	Point out that brake horsepower is commonly computed using an engine on a chassis dynamometer.	Brake Horsepower (bhp) Actual useable horsepower delivered at the crankshaft.
7. Define gross and net horsepower.	Point out that under SAE (Society of Automotive Engineers) specifications, the test conditions--barometric pressure, air temperature and humidity are the same for both gross and net ratings. True horsepower is determined by using a chassis dynamometer at the drive wheels.	Gross Horsepower Maximum horsepower developed by engine without a fan, air cleaner, alternator, exhaust system, etc. Net Horsepower Maximum horsepower developed by engine equipped with fan, air conditioning, air cleaner, exhaust system and all other systems and items normally present when engine is installed in car.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Explain volumetric efficiency.	Point out to students that volumetric efficiency is the amount of air fuel that can be drawn into the cylinder as compared to cylinder volume.	
9. Calculate problems using the cubic-inch formula.	Point out that engine size, which is referred to in cubic inches, is also identified in metric measure (litres).	Conversion Scale 1 litre = 60.52 cu. in. (Cubic inch displacement multiplied by .0164 = litres)
10. Calculate problems using the compression-ratio formula.	Point out that compression ratios are important because they improve power and economy, and that current ratios have been lowered somewhat to improve emission control.	Compression Ratio The relationship between the cylinder volume, with the piston at TDC, as compared to cylinder volume at BDC. TDC = Top dead center of piston travel BDC = Bottom dead center of piston travel
11. Explain the effects of emission controls when testing engines.	Point out the importance of emission controls and that properly functioning emission controls are a factor to engine performance.	

IGNITION SYSTEMS: TUNE-UP (PM201-04)

Major Objective: To provide the student with an understanding of the principles of minor and major ignition tune-up.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. MINOR TUNE-UP The student should be able to:		
1. Explain the need for a tune-up.	Emphasize to students that regular engine tune-ups are required to provide peak engine performance and good gas mileage.	
2. Identify hazards associated with tune-ups.	Emphasize that safety in an Industrial Arts lab includes avoiding injury to self and others, and avoiding damage to vehicles, equipment, and supplies in the shop.	
3. Identify the components of a conventional ignition system.	Discuss the items to be checked or serviced in the conventional ignition system.	
4. Identify the components of an electronic ignition system.	Have students point out the differences between an electronic ignition system and a conventional contact point system. Use charts, transparencies and filmstrips.	
5. Identify the components of a computerized ignition system.	Explain how a computerized ignition system operates. Use charts, transparencies, etc., to show the features within different computerized ignition systems.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Perform a dwell test and rpm test.	Point out that shop manuals contain specifications and specific service procedures and help to eliminate mistakes when performing service.	rpm = Revolutions Per Minute
7. Perform timing tasks.	Have students perform timing tasks on various engines whenever possible.	
8. Identify tools and equipment for tune-up procedures.	Alert students to the special tools and equipment required in performing a tune-up. Acquaint students with visual inspection tests, and use transparencies, charts and manuals enabling students to describe basic diagnostic tune-up procedures.	
9. Correct minor ignition problems.	Encourage students to refer to manufacturers' shop manuals for details about diagnosing problems, checking, disassembly, assembly and replacing procedures.	
10. Demonstrate minor trouble-shooting tasks on the conventional and electronic ignition systems.	Point out the importance of practicing various tune-up procedures.	Newsletter (Champion Spark Plug Co.)

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. MAJOR TUNE-UP		
The student should be able to:		
1. Work in a safe manner with ignition systems.	Emphasize safety precautions, cleanliness, and proper use and care of tools and equipment. Caution students to perform ignition repair only with the ignition switch in off position.	
2. Describe engine tune-up procedures.	Acquaint students with visual inspection steps and have them perform these steps.	
3. List items to be checked in performing a tune-up.	Give students identification tests whereby they list items to be checked when performing a major tune-up.	
4. Identify special engine tune-up instruments.	Alert students to the special tools and equipment required and the proper use of each in performing an engine tune-up.	Tune-Up Equipment 1. Dwell meter 2. Tach meter 3. Volt meter 4. Timing light 5. Ignition point wrenches 6. Distributor wrench 7. Vacuum pump

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Explain the need for a wet and dry compression test.	Point out the importance of volumetric efficiency to proper engine performance.	
6. Perform a complete compression test.	Have students refer to procedures as outlined in the shop manual. Have students remove and replace a complete distributor assembly.	
7. Diagnose tune-up problems.	Have students practice various troubleshooting techniques with the use of diagnostic equipment.	
8. Perform a tune-up.		

FUEL SYSTEMS: CARBURETION-FUEL INJECTION-OVERHAUL (PM201-05)

Major Objective: To develop an understanding of how different fuels and accessories affect carburetion and fuel injection and to develop knowledge to overhauling, setting up and fine-tuning carburetors.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Identify various energy propellants.	Have students prepare a list and discuss the characteristics of various fuels. Discuss the source of fuels, fuel makeup and grades of gasoline by their octane rating.	Energy Propellants 1. Alcohol (Gasohol) 2. Liquid Propane Gas 3. Diesel 4. Gasoline 5. Nitrogen 6. Hydrogen
2. Explain the purpose of fuel additives.	Point out that for top performance and good gas mileage, a gasoline requires various fuel additives.	Purpose of Additives 1. Proper volatility 2. Detonation 3. Oxidation inhibition 4. Anti-icing 5. Anti-rusting 6. Dye for identification 7. Detergents to keep the carburetor clean
3. Identify the additives that makeup fuel.		Fuel Additives 1. Methylcyclopentodienyl manganese tricarbonyl (MMT) 2. Tetraethyl lead (TEL)

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Describe operating principles of the carburetor.	Use models, charts, filmstrips, transparencies. Emphasize that a carburetor works on the principle of pressure differences and ventri-action to provide a well balanced air/fuel mixture.	
5. Name the main parts of a simple carburetor.	Using charts, models, transparencies, have students locate and name the various parts of a simple carburetor.	Main Carburetor Parts 1. Air horn 2. Main body 3. Throttle body
6. Identify the various parts of a simple carburetor.		Various Carburetor Parts 1. Choke 2. Throttle valve 3. Float 4. Needle and seat 5. Accelerator pump 6. Circuits
7. Overhaul a simple carburetor.	Provide students with a simple carburetor and specifications in order to do an overhaul. Discuss the importance of cleanliness and proper sequence of events. Emphasize safety when handling carburetor cleaners.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Perform various internal carburetor adjustments.	Demonstrate basic internal adjustments and explain their importance to engine performance.	
9. Fine-tune a carburetor.	By using special test equipment, have students tune a carburetor on a warmed-up engine.	
10. Explain procedures for diagnosing carburetor-related problems.	Point out to students that carburetor-related problems must be diagnosed by a process of elimination.	
11. Demonstrate trouble-shooting methods which relate to carburetion.	Discuss with students and demonstrate methods of diagnosing carburetion problems by providing actual troubleshooting activities on an engine.	
12. Demonstrate an understanding of the gasoline fuel injection system.	Have students discuss and define the fuel injection system.	Fuel Injection A system that uses no carburetor but sprays fuel either directly into parts or into an intake manifold.
13. List the types and classifications of fuel injection systems.	Use transparencies, filmstrips, charts to help students identify the types and classifications of fuel injection systems. Acquaint students with different designs and discuss the advantages of each.	Classifying Fuel Injection Systems 1. Where injected (Port, Manifold, Throttle body) 2. How injected (Continuous or Intermittent)

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
14. Explain service procedures for fuel injection systems.	Use filmstrips, charts and transparencies.	

BRAKE SYSTEM (PM201-06)

Major Objectives: To develop the student's understanding of the theory and principles of hydraulics, as applied to the brake system.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Identify the hazards related to working on brake systems.	Discuss safety practices as related to working on the brake system. Emphasize the following precautions: prolonged exposure to asbestos may be hazardous to one's health, brake fluid should not be allowed to come in contact with paint, care should be taken with components under tension.	
2. Practice safety procedures related to the brake system.	Follow the general precautions as outlined in the shop manual while servicing brakes.	
3. Describe the purpose and principles of brake operation.	Use charts, filmstrips, transparencies to show the principle of hydraulics as applied to the brake system. Explain that fluid in a confined area is used to transmit motion, pressure and force.	
4. Explain the importance of brake fluid.	Explain to students why brake fluid is used rather than other fluids. Brake fluid must be kept in airtight containers to maintain braking effectiveness.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. List the characteristics of brake fluid.	Have students list and discuss the importance of brake fluid characteristics.	Characteristics of Brake Fluid 1. Low freezing point 2. High boiling point 3. Won't rust metal parts 4. Won't eat rubber parts 5. Non-compressible 6. Will not evaporate 7. Absorbs moisture 8. Damages automotive finishes
6. Explain the operation of a single master cylinder, with its component parts.	Use models, cutaways, charts, transparencies to demonstrate the parts and their operation in a single master cylinder. Have students locate, name, and describe each part in a single master cylinder.	Single Master Cylinder Parts 1. Aluminum cylinder 2. Aluminum piston 3. Primary rubber cup 4. Secondary rubber cup 5. Return spring 6. Reservoir and cover 7. Compensating port 8. Fluid supply port
7. Explain the operation of a dual master cylinder, with its component parts.	Use models, cutaways, charts, transparencies to demonstrate the operation and parts of a dual master cylinder. Have students locate, name and describe each part in the dual master cylinder.	Dual Master Cylinder Parts 1. Aluminum cylinder 2. Primary piston 3. Secondary piston 4. Primary cup 5. Seal retainer 6. Return springs 7. Compensating ports 8. Fluid supply ports 9. Reservoir and cover

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Explain the operation of a quick takeup diagonal master cylinder.	Have students explain the difference between the diagonal master cylinder and the conventional dual master cylinder.	
9. Describe the operation of drum brakes.	Use cutaways, charts, transparencies to show the students the various drum brake designs and their operation. Have students locate and name the parts of a drum brake assembly.	Drum Brake Design 1. Dual-Servo brake 2. Uniservo brake 3. Nonservo brake
10. Describe the operation of disc brakes.	Use cutaways, charts, transparencies to demonstrate disc brake operation. Have students locate and name the parts of a disc brake assembly.	Parts of a Disc Brake Assembly 1. Caliper 2. Pads (disc) 3. Rotor
11. Explain the operation of a combined drum and disc unit.	Point out to students the different valves incorporated to provide for equal braking in a combined drum and disc unit. Have students list brake accessories and discuss their operation in the brake system.	Parts of a Drum Brake Assembly 1. Backing plate 2. Anchor pin 3. Slave cylinder 4. Front and rear shoes 5. Return springs 6. Hold down springs 7. Self adjusting cable and assembly 8. Brake drum

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
12. Describe the operation of power brakes.	Have students list and describe the different types of power brake boosters.	Power Brake Boosters 1. Vacuum brake booster 2. Hydro-Boost power brake 3. Atmospheric brake booster
13. Describe the operation of current innovations to the brake system.	Discuss with students the following: - anti-skid braking - computer-controlled braking	
14. Identify special tools necessary for brake servicing.	Have students list and demonstrate the use of each special brake tool.	Special Tools for Brake Servicing 1. Inside calipers 2. Outside calipers 3. Dial gauge 4. Tubing wrench 5. Three arm hone 6. Brake spring pliers 7. Hold down spring tool 8. Sleeve cylinder piston retainer 9. Vacuum pump 10. Disc brake piston retainer
15. Repair drum and disc brakes.	Demonstrate to students the proper sequence and procedures in doing a brake overhaul. Have students diagnose and perform a brake overhaul.	
16. Bleed a brake system.	Have students perform brake bleeding on various types of brake systems.	

STEERING SYSTEM (PM201-07)

Major Objective: To enable the student to understand steering geometry, and provide an awareness of the various types of steering assemblies.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain steering geometry.	Point out to students that the steering system allows the driver to move the front wheels left or right with minimum movement of the steering wheel. The term, steering geometry, is often used to describe the various angles formed by the front wheels.	
2. List the component parts of a simple steering linkage train.	Have students locate, name and describe the function of each component part.	Steering System Components 1. Steering arm 2. Tie-rod ends 3. Idler arm 4. Center link 5. Pitman arm 6. Adjuster sleeve
3. Explain the parallelogram steering linkage setup.	Point out that the most commonly used arrangement today is the parallelogram type of linkeage. Use a schematic drawing to demonstrate how the axle steering arms and tie rods form the shape of a parallelogram.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Discuss a schematic drawing of a rack and pinion steering system.	Have the students draw, locate and name the component parts of a rack and pinion steering system.	
5. List the component parts of a simple rack and pinion steering system.	Discuss the function and importance of each component part in the rack and pinion steering system.	Rack and Pinion System 1. Housing 2. Pinion 3. Rack 4. Tie rod 5. Oil seal 6. Column tubes
6. Explain the need for a steering gear box.	Emphasize to students that a steering gear box is a turning torque multiplier, which allows the wheels to turn easily.	
7. List the different types of manual steering gear boxes.	Use models, transparencies, filmstrips, and charts to demonstrate how the different gear boxes operate.	Manual Steering 1. Recirculating-ball steering 2. Rack and pinion steering
8. Describe how each manual gear box works.		
9. Name the types of power steering systems.		Power Steering Systems 1. Self-contained 2. Linkage type

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Describe how each power steering system works.	Use charts, models, transparencies, and filmstrips to demonstrate how the different power steering systems work.	
11. Describe the different types of collapsible steering columns.	Point out to students that because of collision impact, the steering column and gear shift are collapsible. Emphasize that the steering column often includes: - turn signal switch - ignition switch - headlight dimmer switch - windshield wiper switch - gear shift lever - speed control - tilt and telescoped steering - horn wiring	Collapsible Columns 1. "Japanese-lantern" type 2. Tube and Ball type
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SUSPENSION AND FRONT-END ALIGNMENT (PM201-08)

Major Objective: To enable the student to understand the operation of the suspension system in relation to front-end alignment.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain the need for suspension systems.	Emphasize to students that the suspension system is designed to provide the best ride, control, and handling of a vehicle along with safety, stability and long service.	
2. Describe the operation of leaf spring and coil spring suspension.	Use charts, models, and filmstrips to demonstrate how leaf springs and coil springs operate. Show examples of where each is used.	
3. Describe the operation of torsion bar suspension.	Use charts, transparencies, to point out to students how the torque (twisting action) of steel is used to provide a spring action suspension.	
4. Explain I-beam suspension.	Describe the combination of solid axle, I-beam, and independent suspension systems.	
5. Explain solid axle suspension (front and back).		

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Explain front-wheel independent suspension operation.	Emphasize that there are several types of front-wheel suspensions. Have students describe and give examples of each.	Types of Front Suspensions 1. Long and short arm 2. Strut single control arm 3. Monobeam 4. Twin-I-Beam 16mm film: "A Question of Springing", Shell Oil
7. Describe 4-wheel independent suspension.	Point out that depending on the manufacturer, different types of suspensions may be used on 4-wheel independent suspension.	
8. Describe the purpose of shock absorbers.	Emphasize to students that shock absorbers must reduce spring occillation to give a stable and safe ride. Describe a shock absorber operation by using charts and models.	
9. List various types of shock absorbers.	Explain where and when different types of shock absorbers would be used.	Shock Absorbers 1. Air shocks (manual) 2. Air shocks (Auto control) 3. Fluid movement shocks 4. Gas filled shocks
10. Explain the need for a stabilizer bar.	Have students locate and describe the function of a sway bar, both on front and rear suspension.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
11. Understand the importance of wheel alignment.	Emphasize to students that a wheel alignment provides maximum ease of handling, control, reduced tire wear, reduced front-end wear, and safety on the road.	VHS, 1985 Total Alignment-Passenger Cars, Stephenson Equipment Company, Winnipeg
12. Describe the principles of wheel alignment.	Use charts, transparencies, filmstrips to point out to students that a wheel alignment consists of various steering angles and that different makes and models of vehicles require different settings.	Steering Angles 1. Tracking 2. Camber 3. Caster 4. Steering axis inclination 5. Toe-in 6. Toe-out
13. Describe toe-in at a stationary position.	Indicate to students that linkage play in the steering system can only be corrected by setting the front wheels inward at the stationary position.	Toe-In The amount, in inches or millimetres, by which the front of a front wheel points inward.
14. Described toe-out at a turning position.	Emphasize to students that the inner front wheel on a curve always turns a few degrees more than the outer front wheel. Discuss the Ackerman Principle whereby only the wheels and the steering knuckles swing, instead of the whole axle as in a horse-drawn vehicle.	Toe-Out The difference between the angles each of the front wheels makes with the vehicle frame during turns. On a turn, the inner wheel turns or toes out more.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
15. Recognize the relationship between front-end and rear-wheel alignment and steering systems.	Indicate to students that steering geometry and wheel alignment are alike in that both provide directional control, ease of handling, stability, reduced tire wear, and safety.	
16. Identify tools necessary for front-end repair.	Have students list and describe the use of each tool for front-end repair.	Front-End Equipment 1. Wheel alignment machine 2. Tire run out indicator 3. Tie rod sleeve wrench 4. Steering wheel holder 5. Brake pedal depressor

DRIVE TRAIN: CLUTCH-TRANSMISSION-DIFFERENTIAL (PM201-09)

Major Objective: To enable the student to understand engine power transmission systems.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. CLUTCHES		
The student should be able to:		
1. Identify the hazards related to various aspects of the drive train.	Emphasize to students that when working on drive trains, the ignition key must be removed and, in some cases, the battery disconnected.	
2. Explain the need for a clutch.	Point out to students that a clutch provides the means of connecting and disconnecting the engine from the drive train.	
3. List the parts of a clutch assembly.	Use charts, models, and filmstrips to locate and describe the parts and operating principles of the clutch assembly.	
4. Describe the operating principles of the clutch.	Have students follow the power flow from the engine to the transmission.	Parts of a Clutch Assembly 1. Flywheel 2. Clutch housing 3. Pressure plate 4. Clutch disc

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Identify the different types of clutch assemblies.	Have students list and describe the different types of clutch assemblies.	Clutch Assembly Types 1. Diaphram-spring clutch 2. Coil-spring clutch 3. Multi-disc clutch 4. Wet and dry clutch 5. Centrifugal clutch
6. Identify different clutch troubles.	Discuss with students various clutch terminology related to troubleshooting: - clutch pedal "free travel" - linkage adjustments - hydraulic clutch - release bearing - chatter - slippage - vibration	
7. Identify tools necessary for clutch repair.	Have students list tools required and discuss the use of speciality tools for clutch repair.	Tools for Clutch Repair 1. Bushing driver 2. Slide hammer puller 3. Dial indicator 4. Clutch alignment tools
8. Adjust a clutch assembly.	Demonstrate to students the procedures and sequence of events required to do a proper clutch replacement and clutch adjustment.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Remove and replace a clutch assembly.		
B. TRANSMISSION		
The student should be able to:		
1. Describe the purpose of a transmission.	Point out to students that the purpose of a transmission is to provide the operator with a selection of forward gear ratios, reverse gear, and to allow for engine braking.	
2. List and describe the parts of a manual transmission.	Discuss the importance of the various parts of the transmission as they relate to their separate speciality of operation within the manual transmission.	Parts of Manual Transmission 1. Input shaft 2. Main drive gear (input) 3. Main drive gear (cluster) 4. Cluster gears 5. Reverse idler gear 6. Output drive gears (1st, 2nd, 3rd and reverse) 7. Output shaft 8. Syncronizers 9. Shift lever 10. Transmission case

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Explain the operation of a simple manual transmission.		
4. Explain the function of the drive line.	Emphasize to the students that a drive line transfers driving torque from the transmission to the driving wheels of a vehicle.	
5. List and describe the parts of a front-wheel drive assembly transaxle.	Have students draw a transaxle chart, listing the component parts of the drive assembly. Discuss the various designs, including overdrives, that are used at the present time.	
6. Describe types of universal joints.	Using the proper tools and equipment, demonstrate how to replace a universal joint on a rear-wheel drive propeller shaft. Emphasize the importance of using the correct type of universal joint. Discuss hanger bearing operation.	Types of Universal Joints 1. Cross and roller 2. Ball and trunnion 3. Constant velocity universal joint
7. Repair a rear-wheel drive propeller shaft universal joint.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
C. DIFFERENTIAL The student should be able to:		
1. Describe the purpose of a differential.	Point out that if a vehicle were to be driven in a straight line without having to make turns, no differential would be necessary.	
2. Identify the components of a rear-wheel drive assembly.	Discuss with students the importance of each part with regard to the operation each must perform within the rear-wheel drive assembly.	Parts of Rear Wheel Drive Assembly 1. Axle shafts 2. Bearings (pinion shaft) 3. Seals 4. Crown and pinion gears 5. Spider gears 6. Side axle gears 7. Pinion pin 8. Carrier 9. Carrier bearings 10. Housing
3. List the different types of rear-axle assemblies.	Use filmstrips, charts, and models, to describe how each rear-axle assembly is mounted. Explain how each assembly operates.	Types of Rear-Axle Assemblies 1. Dead axle 2. Live axle

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. List the different types of traction or grip differentials.	Have students list the different types of differentials and describe their function by using flow charts, cutaways or drawings.	Types of Differentials 1. Limited slip 2. Posi-trac 3. Sure-grip (Chrysler)
5. Describe the construction and operating principles of the differentials.	Emphasize that the differential must be constructed of quality material to withstand tremendous torque application. Have students draw flow charts to enable them to understand and describe how a differential operates under all driving conditions.	
6. Describe the importance of the crown and pinion tooth pattern.	Describe to students the materials of which the crown and pinion are made. Demonstrate how the hypoid drive tooth pattern enables lowering of the drive shaft for rear-wheel drive vehicles.	
7. Demonstrate an awareness of the four-wheel drive system.	Discuss with students how a four-wheel drive system operates with its accessories and transfer case.	

HEATING AND AIR CONDITIONING (PM201-10) Option

Major Objective: To provide the student with an understanding of heating and air-conditioning principles.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain how a heating system operates.	Discuss with students the various methods employed to provide heat in today's vehicles. Use charts, textbook, and transparencies to describe various operation modes of the heating system.	
2. List the different methods of heat-output control.	Have students list, locate and describe how each output control mode operates.	Methods of Heat-Output Control 1. Air conditioner 2. Defrost 3. Heat 4. Bi-Level 5. Vent
3. Explain the need for a water valve.	Emphasize the importance of regulating water flow to the heater core under various conditions.	Water Value A device which operates by vacuum to shut off water flow.
4. Describe the function of a thermostat.	Discuss with students how the thermostat operates under all types of driving conditions.	Thermostat A temperature-sensitive device used in cooling systems to control the flow of coolant in relation to the engine temperature.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Explain the need for air conditioning in all types of weather.	Emphasize that an air conditioner when properly used, is a comfort-control centre; i.e.: - cools the air in the summer - cleans the air - dehumidifies the air - humidifies the air	
6. List the principles of refrigeration.	Have students list and explain the principles of refrigeration.	Refrigeration Principles 1. Quantity of heat 2. Intensity of heat 3. Transfer of heat 4. Amount of humidity
7. List the component parts that makeup an air-conditioning unit in an automobile.	Use charts, models, and transparencies to describe the component parts in a simple air-conditioning unit.	Air-Conditioning Components 1. Controls 2. Compressor 3. Evaporator 4. Condenser 5. Hoses and lines
8. Describe the operation of a manual refrigeration system.	Emphasize the use of Refrigerant-12 in the operation of both the manual and automatic refrigeration systems. Indicate the importance of Refrigerant-12 in relationship to temperatures and pressures.	Refrigerant-12 (R-12) Name applied to liquid refrigerant used in automotive air conditioning.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Describe the operation of an automatic refrigeration system.	Point out to students the differences between manual controls and automatic controls, along with other accessories which accompany both AC units.	
10. Explain the operation of a cycling clutch orifice tube (CCOT)compressor.	Emphasize to students that CCOT compressors only run when temperatures or pressures are above 0°C or 29 psi. If either should fall below the reading, the CCOT compressor will shut off.	
11. Explain a schematic drawing of a simple car air-conditioning unit and label the major component parts.	Have students draw, locate, name, and describe the component parts of an air-conditioning unit.	
12. Demonstrate safe use of air-conditioning test equipment.	Emphasize the importance of always wearing safety glasses when working with air-conditioning test equipment.	
13. Demonstrate how to discharge an air-conditioning unit.	Point out that when discharging an air-conditioning unit there should be no flames present as freon changes to a poisonous gas. Have students identify safety precautions that must be observed when handling Refrigerant-12.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
14. Demonstrate how to recharge an air-conditioning unit.	In recharging, never over fill the air-conditioning system. Make certain that the system has the exact amount of refrigerant.	
15. List all the dangers when working with refrigerant.	Have students list the dangers of R-12. Point out the need for safety glasses and, in some cases, protective clothing.	Dangers of Refrigerant(R-12) 1. Heavier than air 2. Deadly when mixed with smoke 3. Can blind people if sprayed into eyes 4. Can freeze skin on contact
16. Perform some minor troubleshooting and repairs on air-conditioning units.	Demonstrate to students different methods of testing AC units. Have students diagnose and repair minor problems.	

ENGINE REBUILDING (PM201-11) Option

Major Objective: To provide the student with an understanding of the procedures and skills required for engine rebuilding.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Identify all safety requirements as they relate to engine rebuilding.	Have students list various safety precautions to engine rebuilding, and discuss recommended working procedures.	
2. Identify the need for an engine rebuild.	Point out that it is essential that a thorough understanding of the purpose, construction, and operation of the engine and all of its component be acquired before an intelligent diagnosis and service can be performed.	
3. Demonstrate the ability to remove an engine.	Emphasize that students should follow the sequence and precautions found in shop manuals.	
4. Demonstrate the ability to disassemble an engine systematically.	Have students store components in a safe manner so that they will not be damaged or misplaced.	
5. Inspect and assess the wear of parts.	Point out that all parts must be cleaned before inspection takes place. Accuracy requires that measurements be taken at room temperature.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Replace or repair worn parts.	Discuss with students when parts should be repaired or replaced. Estimate the service life of the engine after proposed repair.	
7. Reassemble the engine.	Follow the shop manual for reassembly procedures. Point out the importance of torque to all components.	
8. Identify safe procedures when installing an engine.	Have students list various safety procedures when replacing an engine, and discuss recommended working precautions.	
9. Install the completed engine.		
10. Demonstrate start-up procedures, and do all final adjustments required for fine tuning.	Demonstrate to students the various final adjustments to the engine. Point out the importnce of running the engine unit until normal temperature has been reached, and of rechecking adjustments. Emphasize that all engines must be thoroughly checked, both visually and with test equipment, before going on a road test.	

power mechanics 301

POWER MECHANICS 301

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STUDENT ORIENTATION AND SAFETY (PM301-01)

Major Objective: To enable the student to explore and relate the significance of power mechanics to the needs of individuals, industry and society, and to develop safe practices and competency in the use of of tools, machines and processes.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. STUDENT ORIENTATION		
The student should be able to:		
1. Outline the historical development of power mechanics.	Discuss the historical development of automotive construction from the era of the horseless carriage to the present.	
2. Demonstrate an awareness of the modules in Power Mechanics 301.	Use transparencies, charts, handouts to provide students with information about the various modules to 301 Power Mechanics. Discuss with students the goals which are common to all levels of Industrial Arts.	
3. Review the course requirements for 301 Power Mechanics.	Provide students with a course outline and discuss the topics to be covered.	
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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Identify and use reference materials.	Bring examples of reference materials to class. Explain their significance and limitations.	Reference Materials 1. Catalogues 2. Textbooks 3. Service manuals 4. Periodicals 5. Tool manuals 6. Directories 7. Audio-visual materials
5. Identify careers associated with power mechanics.	Refer to the career opportunities section of the textbook. Bring in additional information from guidance department, manpower, and other career information sources.	
6. Locate information about power mechanics occupations.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. SAFETY The student should be able to:		
1. Demonstrate an understanding of the need for safety and safety equipment.	Conduct shop tour(s), noting the location and need for various pieces of safety equipment. Explain the functions of this equipment and demonstrate where appropriate.	Safety Equipment 1. Safety glasses 2. Footwear 3. Guards 4. Head gear 5. Ear plugs 6. Gloves
2. Demonstrate an understanding of standards as they apply to the power mechanics lab and the automobile.	Acquaint students with the legislation applicable to the workplace, and safety issues, the various codes, and any safety programs commonly found in industry.	
3. Describe procedures to be followed in the power mechanics lab.		
4. Demonstrate safety habits.	Emphasize the need for safety at all times and stress that the safe way is the only way to carry out a related task.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. List hazardous conditions in the power mechanics lab.	While any shop activity has a certain hazard level, the more hazardous tasks should be noted as these may require direct teacher supervision; i.e., pressing bearings, fuel tank removal, etc.	Circumstances or Equipment with Potential Dangers 1. Hand tools 2. Compressed air 3. Power tools/equipment 4. Jacking devices 5. Hoists 6. Jack stands 7. Hot metal 8. Co-venting 9. Welding equipment
6. Identify emergency procedures.	Review emergency procedures related to first aid, fire and accidents. Note location of eye wash station(s), power switches, alarms, and panels.	
7. Explain the use of fire blankets and fire extinguishers.	Discuss different types of fire extinguishers and their limitations. Provide students with additional information which would alert them to fire drill procedures, types of fires, and other common precautions.	
8. Demonstrate an understanding of accident reporting procedures.	Outline procedures for reporting accidents, i.e., forms, information required, etc. Teachers should have information on any health problems students might have; e.g. epilepsy, hemophilia.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Wear apparel appropriate for a power mechanics lab.	Outline appropriate clothing and stress the need for eye protection. Indicate the hazards of wearing rings, watches, etc. NOTE: EYE PROTECTION SHOULD BE MANDATORY FOR ALL LAB ACTIVITIES.	
10. Demonstrate proficiency in safety.	Although safety is an ongoing process, a safety pre-test should be conducted before students participate in shop activities. Additional tests will be required as the lab tasks expand.	

Major Objective: To provide the student with an understanding of the functions of various automotive electrical components.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
A. STARTERS		
The student should be able to:		
1. Explain the need for safety when dealing with electrical systems.	Emphasize the hazards related to starter operation and testing.	
2. Identify the function of starters.	Explain that a common way to start an engine is to crank it with an electrical starting motor. These are small, powerful motors that convert electrical energy from the battery into mechanical energy.	
3. List the types of starters found on automobiles.	Look at different types of starters, if available. Use transparencies and/or live models to point out the location of starters.	Types of Starters 1. Reduction drive 2. Positive engagement 3. Standard solenoid cranking motor
4. List the components of a simple starter.	Refer to a disassembled starter, noting the components.	Starter Components 1. Housing 2. Armature 3. Pole shoes-field coils 4. Brushes 5. Comutator 6. Starter drive 7. Washers, bushing, etc.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Describe the theory behind starter operation.	Use film strips or slides to demonstrate starter operation.	
6. Explain the need for a solenoid.	Explain that a solenoid is an electrochemical device, which, when connected to an electrical source such as a battery, produces a mechanical movement. This movement can be used to control a mechanical or an electrical device.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
7. Identify the component parts of a solenoid.	Disassemble several different types of solenoids noting the parts. Typical solenoid problems can be observed at this time.	Solenoid Components 1. Solenoid windings 2. Starter terminal 3. Battery terminal 4. Plunger 5. Ignition switch terminal 6. Shift lever
8. Describe the theory behind solenoid operation.		Solenoid An electrically operated magnetic device used to operate various units by movement of an iron core which is activated when current flow is placed through a coil.
9. Describe the function of the starter drive.	Disassemble a starter drive, noting its function and reasons for malfunction.	
10. Test and identify starter and solenoid components.	Demonstrate the use of test equipment. Refer to reference books and manuals for data.	
11. Diagnose and repair starter problems.	Have students remove and repair starters, using the test equipment available.	
12. Disassemble and assemble a starter.		

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
13. Discuss and label a schematic of the starter motor and solenoid.	Have students draw and label a starter motor with a solenoid.	
14. Explain the function of a relay.	Disassemble a relay and study its design and function.	Relay Magnetically operated switch used to make and break flow of current in circuit.
15. Explain the function of a neutral safety switch.	Have students locate the neutral safety switch. Troubleshoot a no-start problem using appropriate test equipment.	Neutral Safety Switch A device used to prevent startin an engine in gear.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
B. ALTERNATORS		
The student should be able to:		
1. List the requirements necessary to produce electricity.	Point out that all sources of electrical energy convert other forms of energy into electricity. Have students provide examples and a description of each; i.e.: 1. Chemical Energy - electrolyte (storage batteries, dry cells) 2. Light - solar cells (satellites, digital watches) 3. Pressure - piezoelectric (microphones, telephones) 4. Heat - thermocouple (foundry furnace) 5. Magnetism - magnetic field (alternators, generators) 6. Friction - static (comb)	Sources of Electricity 1. Chemical Energy 2. Light 3. Pressure 4. Heat 5. Magnetism 6. Friction
2. Explain the function of an alternator.		Alternator A device which produces alternating current. The alternating current must be rectified before it reaches a vehicle's electrical system.
3. Identify the three common types of alternators.	Have examples of different types of alternators on hand to demonstrate for students.	Types of Alternators 1. Grounded brush 2. Insulated brush 3. Isolated field

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. List the component parts of an alternator.	Disassemble a typical alternator noting the function and location of various components.	Alternator Components 1. Housing 2. Rotor 3. Bearings (front and rear) 4. Stator 5. Brushes 6. Diode trio 7. Regulator 8. Fan 9. Pulley
5. Describe the theory of operation of an alternator.		
6. Test and repair problems.	Have students use test equipment to check and diagnose alternators while the vehicle is running. Have students disassemble an alternator and check each component.	
7. Describe the function of a diode.	Supply different types of diodes. Demonstrate how a diode works and how it is checked.	Diode A unit which passes electric current in one direction, resisting current flow in reverse.

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Explain the need for a regulator.	Using test equipment, check a good charging system, and note results. Bypass the regulator and note results. Make students aware of over- or undercharging.	
9. List the types of regulators in use.	Demonstrate sample models of regulators for students.	Types of Regulators 1. Electronic voltage (solid-state) 2. Electromechemical 3. DC Three-Unit
10. Describe the operation of a voltage regulator.	Emphasize to students that the modern electronic voltage regulator is a sealed unit and cannot be repaired.	Voltage Regulator An electrical device used to control alternator or generator voltage and the current output.
11. Test and explain regulator problems.	Use manuals when conducting tests on regulators, and compare the results between the manual recommendation and the test.	
12. Inspect and repair wiring problems.	Have students inspect and test wires with an ohmmeter.	

EXHAUST SYSTEMS (PM301-03)

Major Objective: To develop an understanding of the importance of exhaust systems and their accessories.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain the need for safety when working with exhaust systems.	Emphasize to students the many hazards the exhaust system presents and the precautions to be followed.	
2. Explain the need for an exhaust system.	If a gas analyzer is available, demonstrate the emissions from a typical engine.	
3. Identify the types of exhaust systems.	Use visual aids and live models to show the different systems and components, noting the function of each.	Types of Exhaust Systems 1. Conventional - single - dual 2. High Performance - headers - low restriction - high flow expansion chamber

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OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. List the parts of the exhaust system.	Make students aware of the need for proper exhaust parts to obtain the best engine performance.	Parts of Exhaust System 1. Exhaust manifold 2. Exhaust pipe or crossover 3. Muffler 4. Resonator 5. Catalytic converter 6. Tail pipe 7. Clamps 8. Gaskets 9. Heat riser valve
5. Describe the need for each exhaust system component.		
6. List the types of mufflers.	Make cutaways of various types of mufflers and discuss how they work.	Types of Mufflers 1. Chambered 2. Baffle 3. Straight through 4. Reverse-flow
7. Identify the functions of catalytic converters in use.	Use examples or cutaways of a catalytic converter wherever possible for demonstration.	Types of Catalytic Converters 1. Biscuit type 2. Two-way oxidizing type 3. Three-way oxidizing type Catalytic Converter Part of an exhaust system to reduce harmful emission.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
8. Describe the function of a resonator.	Have students locate a resonator on a car. Emphasize to students the importance of a good free-flowing exhaust system for the best engine performance.	Resonator Small muffler-like device that is placed into an exhaust system nea the tail pipe to provide additional silencing of exhaust noises.
9. Diagnose exhaust system problems.		
10. Repair or replace exhaust system components.	Demonstrate and have students replace or repair exhaust components.	

AUTOMATIC TRANSMISSIONS (PM301-04)

Major Objective: To provide the student with an understanding of the basic operation of an automatic transmission.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain the need for safety when working with automatic transmissions.	Emphasize the precautions to take when working with transmissions, and other safety factors during disassembly and reassembly.	
2. Explain the theory behind hydraulics.	Make reference to other hydraulic systems studied previously.	Hydraulics The use of a liquid under pressure to transfer force or motion, or to increase an applied force.
3. List the different types of automatic transmission fluids.	Have samples of various transmission fluids. Emphasize the importance to follow manufacturers' recommendations and check regularly the proper level of automatic transmission fluid.	Types of Transmission Fluids 1. Dexron II 2. Type A 3. Type CJ 4. Type F 5. Type H
4. List the various types of torque converters.		Types of Torque Converters 1. Splitter gear 2. Centrifugal clutch lock-up 3. Hydraulic clutch lock-up 4. Electric lock-up

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Explain torque converter theory of operation.	Use a disassembled torque converter to explain its operation.	
6. Explain the lock-up operation within a torque converter.	Use cutaways or flow charts of a lock-up torque converter. Use transparencies, charts, etc., to demonstrate the power flow at various speeds.	
7. List the common types of automatic transmissions.		Types of Automatic Transmissions 1. Torqueflite (Chrysler) 2. C5 (Ford) 3. THM 700-R4 (G.M.) 4. Turbo-Hydra-Matic (G.M.) 5. ATX Transaxle (Ford)
8. Describe the basic operations of an automatic transmission.	Have students disassemble a typical transmission and become familiar with all the components. Identify all the gears on a model or cutaway transmission. Set the transmission gears in any one of the possible gear selections and trace the path of power through each gear.	
9. Describe the purpose of a hydraulic pump.	Use the disassembled components of a hydraulic pump in the study of the transmission.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
10. Explain the function of clutches.	Using charts or transparencies, demonstrate to students the power flow of a two-speed automatic transmission. Show students clutch and band application at different gear speeds.	Clutch Used to connect or disconnect flo of power from one unit to another.
11. Explain the function of bands.	Use flow charts or live models to show students how the planetary gear assembly operates in various gears.	Bands Made of steel and faced with a bonded friction lining. One end is secure while the other is activated by hydraulics to stop a drum from rotating.
12. Describe the planetary gear system.		Planetary Gear A unit consisting of a ring gear with internal teeth, a sun or central pinion gear with external teeth, and a series of planet gears that are meshed with both the ring and the sun gear.
13. Describe the function of the valve body.	Have students discuss the operation of the valve body, with the use of charts, cutaways and transparencies.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
14. Explain the purpose and function of the governor and modulator.	Demonstrate the use of a governor and modulator in an automatic transmission. Use models or filmstrips to show examples of how each is used.	Governor Designed to control automatically the speed or position of a part. Modulator Pressure control or adjusting valve used in hydraulic systems of automatic transmissions.
15. Explain a power flow chart.	Have students prepare flow charts showing the power flow in the different gear selections.	
16. Perform basic trouble-shooting tasks.	Demonstrate the various pieces of test equipment available. Emphasize the precautions to be considered when doing a stall test.	

EMISSION CONTROLS (PM301-05)

Major Objective: To enable the student to identify all the different types of emission systems and their components.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Recognize the importance of clean air.	Point out to students the importance of clean air with reference to the fact that car emissions are toxic.	
2. List the various types of emission control devices.	Have students list the various emission control devices and describe the use of each.	Emission Control Devices 1. Catalytic convertor 2. PCV 3. Evaporative emission control 4. Exhaust gas recirculation 5. Air injection 6. Oxygen sensors
3. Explain how each type of emission control device operates.		
4. Test and verify the operation of emission control devices.	Demonstrate to students the procedures and sequence of testing emission control devices.	
5. Repair or replace emission control devices.	Have students diagnose and repair minor problems.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Diagnose and verify the level of exhaust emissions.	If equipment permits, demonstrate the level of exhaust emissions from a running engine.	
7. Inspect all hoses and connections to the emission control devices.	Emphasize to students that it is essential all emission controls operate well in providing for a smooth running engine and good gas mileage.	

IGNITION SCOPE ANALYSIS PM301-06 (Option)

Major Objective: To provide the student with an understanding of equipment necessary for ignition problem analysis.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain the need for safety when working on the ignition system.	Provide the students with an ignition simulator, ignition mock-up, or an easily accessible automobile engine.	Engine Ignition Components 1. Battery 2. Ignition switch 3. Ballast resistor 4. Coil 5. High tension lead wires 6. Points 7. Condenser 8. Transistor 9. Distributor and cap 10. Spark plugs 11. Pick-up module 12. Armature tooth
2. Explain the need for ignition analysis.	Demonstrate the correct and safe procedures required to connect various types of test equipment. Pay particular attention to the many leads and moving parts of the automobile.	
3. Identify and inspect engine ignition components.	Have students list and describe each component. Use models and charts to show the students each component.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
4. Connect an oscilloscope to electronic and conventional ignition systems.	Demonstrate to students the proper hook-up of an oscilloscope. Have students practice the hook-up if time permits.	Oscilloscope A testing unit which projects visual reproduction of the ignition system spark action onto the screen of a cathode ray tube.
5. Recognize basic scope patterns.	Supply the student with basic scope patterns and outline what takes place at each point or section of the pattern. Contrive faulty patterns and have students troubleshoot the problem.	
6. Identify the various controls and meters on the oscilloscope.	Use the various aspects of oscilloscope technology to diagnose and repair problems of ignition and other engine functions.	
7. Demonstrate an ability to diagnose ignition and related problems as observed on the scope.	Have students use the oscilloscope to demonstrate their ability in diagnosing and solving observed problems.	
8. Solve observed problems and verify the remediation by using the oscilloscope.	Use proper specifications to help identify related problems.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Identify where computer controls are used on automobiles.	Have students list and describe the various computer controls used.	Uses of Computer Controls 1. Ignition 2. Transmission 3. Fuel control 4. Instrument self-checks
10. Describe the function of computer controls.	Become familiar with the basic computer controls. Refer to appropriate manuals with regard to troubleshooting, repair and/or replacement of components as necessary.	
11. List the advantages of computer controls.		Advantages of Computer Controls 1. Better performance 2. Little maintenance 3. More efficient

INSTRUMENTS AND ACCESSORIES (PM301-07) Option

Major Objective: To familiarize the student with various instruments and accessories which provide information and comfort to the users of automobiles.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain safety precautions when working with electrical instruments.	Provide students with examples of instruments and accessories. Outline the location of major components and safety procedures with regard to testing and/or removal. Demonstrate troubleshooting skills. This will require: 1. an understanding of test equipment, 2. use of reference manuals, 3. safety considerations, 4. interpretation of results.	
2. List the major instruments and accessories.		Instrument Accessories 1. Oil light or gauge 2. Alternator light gauge 3. Brake light 4. R.W.D. switch and light 5. Gasoline gauge 6. Cooling system gauge 7. Odometer and speedometer 8. Heater controls 9. Radio controls 10. Wiper controls 11. Lights controls 12. Gear selector quadrant gauge

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
3. Explain the purpose of each instrument and accessory.		
4. Demonstrate the ability to use various testing equipment.	Demonstrate to students the testing equipment used to trace accessories problems.	
5. Diagnose major instruments and accessory problems.	Have students prepare a list of accessories problems. Discuss with students how to diagnose these.	
6. Solve instrument and accessory problems.	Have students practice repairing accessory problems.	
7. Identify other minor accessories found on automobiles.		Minor Accessories 1. Power antenna 2. Power seat 3. Power trunk 4. Auto load levelers 5. Talking computers

ENGINE REBUILDING PM301-08 (Option)

Major Objective: To provide the student with an understanding of the procedures and skills necessary for engine rebuilding.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Identify all safety requirements as they relate to engine rebuilding.	Have students list various safety precautions to engine rebuilding, and discuss recommended working procedures.	
2. Identify the need for an engine rebuild.	Point out that it is essential that a thorough understanding of the purpose, construction, and operation of the engine and all of its components be acquired before intelligent diagnosis and service can be performed.	
3. Demonstrate the ability to remove an engine.	Emphasize that students should follow the general sequence and precautions found in shop manuals.	
4. Demonstrate the ability to disassemble an engine systematically.	Have students store components in a safe manner so that they will not be damaged or misplaced.	
5. Inspect and assess the wear of parts.	Point out that all parts must be cleaned before inspection takes place. Accuracy requires that measurements be taken at room temperature.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
6. Replace or repair worn parts.	Discuss with students when parts should be repaired or replaced. Estimate the service life of the engine after proposed repair.	
7. Reassemble the engine.	Follow the shop manual for reassembly procedures. Point out the importance of torque to all components.	
8. Identify safe procedures when installing an engine.	Have students list various safety procedures when replacing an engine, and discuss recommended working precautions.	
9. Install the completed engine.		
10. Demonstrate the start-up procedures, and do all final adjustments required for fine tuning.	Demonstrate to students various final adjustments to the engine. Point out the importance of running the engine until normal temperature has been reached, and of rechecking adjustments. Emphasize that all engines must be thoroughly checked, both visually and with test equipment, before going on a road test.	

HEATING AND AIR CONDITIONING (PM301-09) Option

Major Objective: To provide the student with an understanding of heating and air-conditioning principles.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
The student should be able to:		
1. Explain how a heating system operates.	Discuss with students the various methods employed to provide heat in today's vehicles. Use charts, textbook, and transparencies to describe various operation modes of the heating system.	
2. List the different methods of heat-output control.	Have students list, locate and describe how each output control mode operates.	Methods of Heat-Output Control 1. Air conditioner 2. Defrost 3. Heat 4. Bi-Level 5. Vent
3. Explain the need for a water valve.	Emphasize the importance of regulating water flow to the heater core under various conditions.	Water Valve A device which operates by vacuum to shut off water flow.
4. Describe the function of a thermostat.	Discuss with students how the thermostat operates under all types of driving conditions.	Thermostat A temperature-sensitive device used in cooling systems to control the flow of coolant in relation to the engine temperature.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
5. Explain the need for air conditioning in all types of weather.	Emphasize that an air conditioner, when properly used, is a comfort control centre; i.e.: - cools the air in the summer, - cleans the air, - dehumidifies the air, - humidifies the air.	Thermostat A temperature sensitive device used in cooling systems to control the flow of coolant in relation to the engine temperature.
6. List the principles of refrigeration.	Have students list and explain the principles of refrigeration.	Refrigeration Principles 1. Quantity of heat 2. Intensity of heat 3. Transfer of heat 4. Amount of humidity
7. List the component parts that makeup an air-conditioning unit in an automobile.	Use charts, models, and transparencies to describe the component parts in a simple air-conditioning unit.	Air-Conditioning Components 1. Controls 2. Compressor 3. Evaporator 4. Condenser 5. Hoses and lines
8. Describe the operation of a manual refrigeration system.	Emphasize the use of Refrigerant-12 in the operation of both the manual and automatic refrigeration systems. Indicate the importance of Refrigerant-12 in relationship to temperatures and pressures.	R-12 (Refrigerant-12) Name applied to liquid refrigerant used in automotive air conditioning.

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
9. Describe the operation of an automatic refrigeration system.	Point out to students the differences between manual controls and automatic controls, along with other accessories which accompany both air conditioning units.	
10. Explain the operation of a cycling clutch orifice tube (CCOT)compressor.	Emphasize to students that CCOT compressors only run when temperatures or pressures are above 0°C or 29 psi. If either should fall below the reading, the CCOT compressor will shut off.	
11. Explain a schematic drawing of a simple car air-conditioning unit and label the major component parts.	Have students draw, locate, name, and describe the component parts of an air-conditioning unit.	
12. Demonstrate safe use of air-conditioning test equipment.	Emphasize the importance of always wearing safety glasses when working with air-conditioning test equipment.	
13. Demonstrate how to discharge an air-conditioning unit.	Point out that when discharging an air-conditioning unit there should be no flames present as freon changes to a poisonous gas. Have students identify safety precautions that must be observed when handling Refrigerant-12.	

OBJECTIVES	TEACHERS' NOTES AND SUGGESTED ACTIVITIES	SUGGESTED MATERIALS
14. Demonstrate how to recharge an air-conditioning unit.	Stress that, in recharging, one should never overfill the air-conditioning system. Make certain that the system has the exact amount of refrigerant.	
15. List all the dangers when working with refrigerant.	Have students list the dangers of R-12. Point out the need for safety glasses and, in some cases, protective clothing.	Dangers of Refrigerant(R-12) 1. Heavier than air 2. Deadly when mixed with smoke 3. Can blind people if sprayed into eyes 4. Can freeze skin on contact
16. Perform some minor troubleshooting and repairs on air-conditioning units.	Demonstrate to students different methods of testing AC units. Have students diagnose and repair minor problems.	

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POWER MECHANICS 101

MODULES	AUTO MECHANICS FUNDAMENTALS	AUTOMOTIVE PRINCIPLES AND SERVICE	THE AUTO BOOK
- Student Orientation & Safety			
A. Student Orientation	---	Chapter 1	Chapter 2
B. Safety			
- Tool Identification & Use			
A. Hand Tools	Chapter 23	Chapter 1, Part 2	Chapter 5
B. Power Tools	Chapter 23	Chapter 2, Part 5	Chapter 5
C. Measuring Tools	Chapter 23	Chapter 2, Part 4	Chapter 3
D. Cutting Tools	Chapter 23	Chapter 1, Part 2	Chapter 5
E. Others	Chapter 23	Chapter 2	---
F. Tool Maintenance	Chapter 23	---	---
- Fasteners and Gaskets	Chapter 2	Chapter 3	Chapter 4
- Use of Manuals	---	Chapter 2, Part 1	---
- Theory of Engine Operation			
A. Introduction	Chapter 9,10	Chapter 5	Chapter 6,7
B. Engine Classification	Chapter 9,10	Chapter 5	Chapter 6,7
C. Internal Combustion	Chapter 9,10	Chapter 5	Chapter 8,9,10
- Lubrication Systems, Lubricants & Bearings			
A. Lubrication	Chapter 5	Chapter 7	Chapter 11
B. Bearings	Chapter 1	Chapter 3, Part 3	Chapter 30
- Fuel Systems			
A. Gasoline Systems	Chapter 7	Chapter 12	Chapter 13
B. Carburetors	Chapter 6	Chapter 13	Chapter 15
C. Fuel Injection	Chapter 7	Chapter 14	Chapter 14,16
D. Diesel Fuel Systems	Chapter 7	Chapter 15	Chapter 17

MODULES	AUTO MECHANICS FUNDAMENTALS	AUTOMOTIVE PRINCIPLES AND SERVICE	THE AUTO BOOK
- Cooling Systems	Chapter 4	Chapter 8	
- Basic Electronics Systems			
A. Basic Electricity	Chapter 21	Chapter 19	Chapter 18
B. Batteries	Chapter 21	Chapter 18	Chapter 19
C. Automotive Circuits	Chapter 21	Chapter 19	Chapter 18
- Basic Ignition Systems			
A. Conventional Ignition System	Chapter 3	Chapter 24	Chapter 22
B. Magneto	Chapter 3	---	---
C. Electronic Ignition System	Chapter 3	Chapter 24	Chapter 22
D. Tune-Up	Chapter 3	Chapter 24	Chapter 26,27, and 28
- Wheels, Hubs & Tires			
A. Wheels	Chapter 18	Chapter 29,30	Chapter 43
B. Tires	Chapter 18	Chapter 29,30	Chapter 43

POWER MECHANICS 201

MODULES	AUTO MECHANICS FUNDAMENTALS	AUTOMOTIVE PRINCIPLES AND SERVICE	THE AUTO BOOK
- Student Orientation & Safety A. Student Orientation B. Safety	---	Chapter 1	Chapter 2
- Engines Types	Chapter 9	Chapter 5	Chapter 8
- Engine Test & Measurement	Chapter 10	Chapter 5	Chapter 7
- Ignition Systems: Tune-Up			
A. Minor Tune-Up	Chapter 3	Chapter 24	Chapter 22
B. Major Tune-Up	Chapter 3	Chapter 24	Chapter 26, 27 28
- Fuel Systems: Carburetion-Fuel Injection and Overhaul	Chapter 6,7	Chapter 12,13,14	Chapter 13,14, 15,16
- Brake System	Chapter 20	Chapter 31	Chapter 38,39
- Steering System	Chapter 19	Chapter 28	Chapter41,42
- Suspension & Front-End Alignment	Chapter 17,18	Chapter 27,30	Chapter 40,42
- Drive Train: Clutch/Transmission/Differential			
A. Clutches	Chapter 11	Chapter 35	Chapter 32
B. Transmission	Chapter 12	Chapter 36,37	Chapter 33
C. Differential	Chapter 12,13	Chapter 34	Chapter 36
- Heating & Air Conditioning	Chapter 22	Chapter 40	Chapter 44,45
- Engine Rebuilding	Chapter 2	Chapter 9	Chapter 26,29,

POWER MECHANICS 301

MODULES	AUTO MECHANICS FUNDAMENTALS	AUTOMOTIVE PRINCIPLES AND SERVICE	THE AUTO BOOK
- Student Orientation & Safety			
A. Student Orientation	---	Chapter 1	Chapter 2
B. Safety			
- Electrical Systems			
A. Starters	Chapter 21	Chapter 21	Chapter 20
B. Alternators	Chapter 21	Chapter 22,23	Chapter 21
- Exhaust Systems	Chapter 8	Chapter 16	Chapter 14
- Automatic Transmissions	Chapter 14	Chapter 38,39	Chapter 34
- Emission Controls	Chapter 8	Chapter 17	Chapter 24,25
- Ignition Scope Analysis	Chapter 3	Chapter 26	Chapter 27
- Instruments & Accessories	Chapter 21	Chapter 25	Chapter 23
- Engine Rebuilding	Chapter 2	Chapter 9	Chapter 26,29,30,31
- Heating & Air Conditioning	Chapter 22	Chapter 40	Chapter 44,45

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20 - 1865 Sargent Avenue
Winnipeg, MB
R3H 0E4
(Mitchell manuals, charts, service bulletins, etc.)

Champion Spark Plug Company of
Canada, Limited
P.O. Box 910
Windsor, ON
N9A 6P2
(Charts, manuals, diagrams, newsletters, etc.)

Curtiss Wright of Canada Incorporated
89 Paramount Road
Winnipeg, MB
R2X 2W6
(Charts, manuals, etc.)

Fel-Pro Incorporated
Box C 1103
Skokie, IL 60076
USA
(Gasket samples, charts, torque specs, etc.)

Ford of Canada
1725 Ellice Avenue
Winnipeg, MB
R3H 0B2
(Posters, charts, models, service publications, etc.)

General Motors of Canada
36 Overlea Boulevard
Toronto, ON
M4H 1B7
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390 Birchmount Road
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(Charts, filters, updates, etc.)

John Deere Technical Services
Department F
John Deere Road
Moline, IL 61265 USA
(Charts, teaching materials, etc.)

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949 Jarvis Avenue
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R2X 0A1
(Aircooled engine charts, manuals, etc.)

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89 Paramount Road
Winnipeg, MB R2X 2W6
(Slides and slide-cassette programs)

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Allied Automotive Shop Talk
105 Pawtucket Avenue
East Providence, RI 02916 USA
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36 Overlea Boulvard
Toronto, ON M4H 1B7
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K 629.245 A98 - Automobile Differential Explained
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K 629.253 O64 - Operation--Fuel System
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K 629.254 E44 - Electronic Ignition Explained
K 629.254 I35 - Ignition System Explained
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K 629.892 R62 - Robotics
K 621.9 S56 - Simple Machines
K 629.2222 U84 - Used Car Buying
K 621.434 S63 - Small Engines Explained
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1800	Diesel Engine (Diesel motor)	10 - 12
1778	Direct Generators: Theory of Operation (Dynamos - Direct current)	10 - 12
4134	Engine Lubrication (Engines, Auto Lubrication)	10 - 12
2044	Hydraulic Brake System (Brakes; Hydraulic brakes)	10 - 12
1993	Hydraulic Steering: Principle of Operation (Automobiles - Steering-gear; Hydraulic machinery; Steering-gear)	10 - 12
2254	Modulo: Variations on a Design (Art; Automobiles - Design and construction)	7 - 12
4133	The Engine (Engines, Automobiles)	10 - 12
0398	The ABC of Internal Combustion Engines (Internal combustion engines; Automobiles, Engines)	4 - 12
1452	The ABC's of Internal Combustion Engines: The Automobile Engine (Internal combustion engines; Automobiles - Motors)	7 - 12
1083	Where Mileage Begins: The Story of the Internal Combustion Engine (4 cycle engines)	4 - 9

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416 Longshore Drive
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Ann Arbor, MI 48107 USA

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GW Goodheart-Willcox Company
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